SEPTEMBER 1958

Power Engineering

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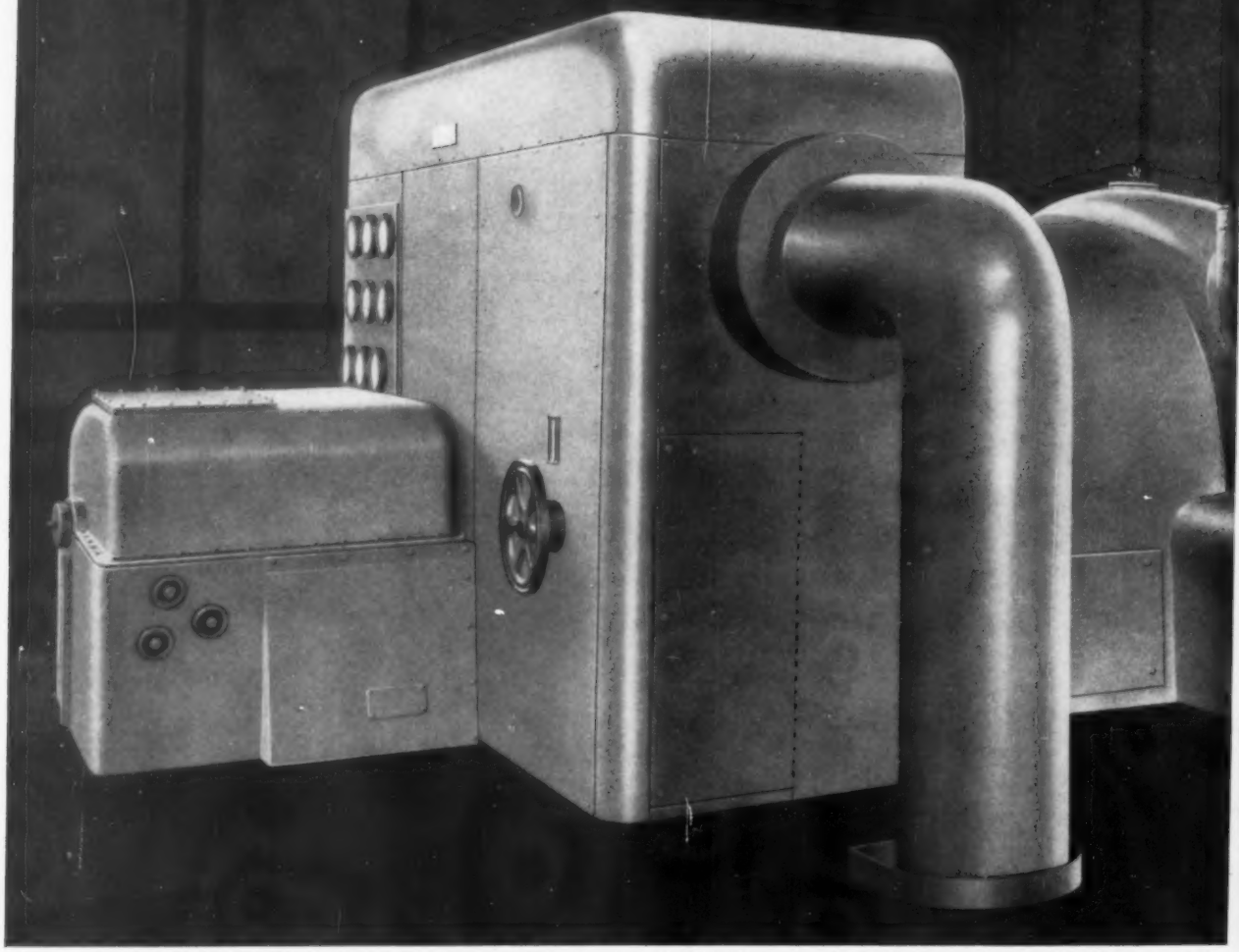
A solid background of TURBINE-GENERATOR



Year after year . . . Elliott turbine-generators are

EXPERIENCE

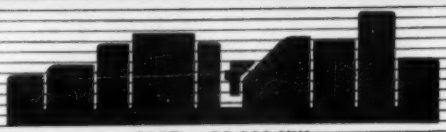
The excellent operation of this 16,500-kw hydrogen-cooled turbine-generator unit is the result of Elliott Company's background of 50 years experience in designing, and building turbine-generator units. The steady march in size ratings is accomplished by a step-by-step introduction of proven components added to each larger size.

Elliott is currently building a 33,000-kw unit and has the facilities, experienced engineers, and craftsmen, to produce size ratings to 44,000 kw. For complete engineering data, call your nearby Elliott district office or write Elliott Company, Steam Turbine Department, Jeannette, Pa.

ELLIOTT Company

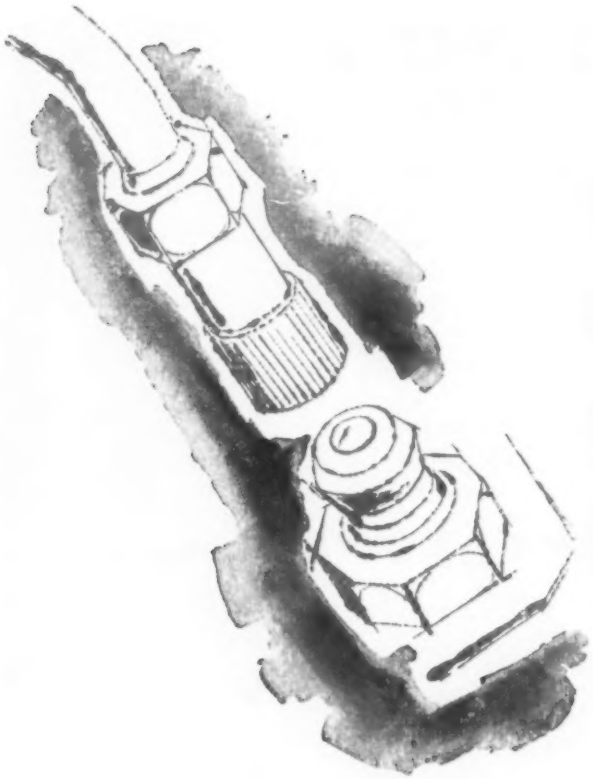
HB-4

In this turbine-generator aisle, Elliott has the large machine tool equipment and handling facilities for manufacturing. Under construction is a 33,000-kw unit—designed and built to meet the exact requirements of the user.



1957 . . . 33,000 KW

getting Bigger and Bigger



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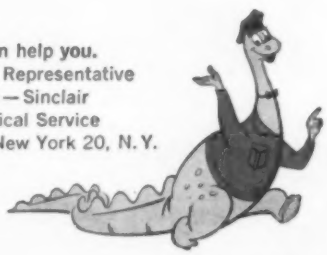
Find out how Litholine can help you. Call your nearest Sinclair Representative or write for free literature—Sinclair Refining Company, Technical Service Division, 600 Fifth Ave., New York 20, N.Y. There's no obligation.



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PUBLISHED SINCE 1896 FOR POWER ENGINEERS IN PRIVATE AND PUBLIC UTILITIES AND INDUSTRIAL PLANTS

ENGINEERS' PREVIEW

SECOND international conference on the peaceful uses of atomic energy is going on in Geneva, Switzerland, 1st to the 13th of this month. Theme of the meeting is power. The U. S. is offering a motion picture program on nuclear energy. Forty-four films, most of them in color, cover all major nuclear applications and research activities. A 50-min film surveys the work now under way in controlled fusion at Los Alamos Lab, the University of California Radiation Lab, Oak Ridge, and Princeton University.

After the conference, prints of this film collection will be sent to AEC's 12 regional film libraries for use by universities, engineering, scientific and industrial groups, and individuals working in the field of atomic energy.

TO PROVIDE reliable flow of coal from bins without arching, rat-holing or funneling, the Easy-Flo Bin device shown here has been developed by BCR.

The bin is attached to the bottom opening of conventional storage

Cut-away view of device

bins and provides a means for controlling the flow of coal or other bulk solids. Once the stored material passes by gravity from the storage bin into the device, a double-cone arrangement within the device maintains the bulk material in an unpacked state. Gravity outflow is assured, it is claimed, because the forces acting on the material are controlled, and conditions that are the cause of stoppages in conventional bins cannot develop.

As an example of its performance, the unit provides problem-free handling of ¼ × 0-in. coal with up to 15 per cent surface moisture, reliable flow with sizes up to 3-in., and has gravity feed rates up to 7000 lb per min.

One machinery manufacturer has been granted a license to manufacture and sell this new device, under a non-exclusive license. For more information, write the Editor.

ASME's Engineers Medal, given for distinguished service in engineering and science, has been awarded to Wilbur H. Armacost, vice president-consultant and chairman of the technical committee at Combustion Engineering, Inc, in New York. Armacost is credited with fostering such developments as the controlled circulation boiler and the supercritical boiler. He has been a pioneer in the development of design and materials adaptable to high temperatures and pressures.

The John Fritz Medal, sponsored jointly by ASCE, ASME, AIEE and AIMMPE, will be given this year to Dr. Mervin J. Kelly, president of Bell Telephone Laboratories. Dr. Kelly was cited for "his achievements in electronics, leadership of a great industrial research laboratory, and contributions to the defense of the country through science and technology."

RECLAIMED OIL — do you use it in new oil circuit breakers? Sixteen West Coast utilities were queried on this point and others connected with practices for transit oil handling. Ten said no, they do not use reclaimed oil.

Usually, however, new oil is not kept separate from reclaimed or filtered oil of various ages which meets the ASTM standard tests, so that eventually the oil in breakers and transformers will be a mixture of old and new. Some companies

expect to improve the quality of the reclaimed oil by such mixing.

Even when new oil is purchased with new equipment, as is generally the case, when the oil is removed from the equipment it is usually put into the most convenient tank even though there may be reclaimed oil in the tank.

The survey, which was taken by an AIEE committee, showed that there are trends toward the use of: 1, mobile equipment; 2, inhibited oil; 3, fixed oil tanks in large stations, but not always piped to equipment; 4, plastic piping where corrosion is a problem; 5, dielectric, acidity and color tests to determine when to change oil for reconditioning.

● $1,250,000 CONTRACT has been awarded the Griscom-Russell Co by the Power Reactor Development Co for the design and manufacture of three sodium-metal heated steam generators and special tube bundles. These are for the new Enrico Fermi Atomic Power Plant in Michigan.

The special involuted trombone-nested type of tube bundles developed for these steam generators will carry the water and resulting steam through the molten sodium metal contained in the shell around the tubes. Heat of the molten sodium, entering the steam generator at 820 F and exiting at 520 F, will generate steam from 380-F feedwater to a superheated temperature of 780 F at 900 psia discharge pressure.

● HIGHEST single contribution to the high cost of nuclear power is probably nuclear fuel charges, says Stanley B. Roboff, marketing director of Sylvania-Corning Nuclear Corp. If nuclear power is ever to be competitive with present-day costs of conventional power, fuel costs must be reduced 200 to 300 per cent. Roboff recommends:

AEC action to develop a low-cost over-all fuel cycle; planning of reactor concepts around low-cost fuel cycles; more effort to obtain in-pile irradiation data on fuels, so that positive information on maximum possible fuel life can be gathered; development of new approaches to the chemical reprocessing of spent fuels to combine a low-cost reprocessing technique with a low-cost fuel element; and development by AEC of a firm long-range schedule of plutonium and uranium-235 buy-back prices.

● GLENN BARTON WARREN, vice president and consulting engineer, turbine division, General Electric Co, has been nominated to serve as the 1959 President of ASME.

Mr. Warren, who is noted for his work in turbine design, has been with

Glenn B. Warren

G-E since 1919. He received his B.S. in Mechanical Engineering from the University of Wisconsin in that year. In recognition of his college work on turbines, G-E gave him the opportunity to initiate a research development program on the flow elements of large steam turbines, which continues to this day.

He has held design and engineering management positions, throughout the intervening years, until promoted to his present position in January 1957. He received his M.E. degree from the University of Wisconsin in 1924 and an honorary D.Sc. from Union College in 1956. He has held many positions in ASME at the local, regional and national levels and at present is serving on the Council.

● AEIC-EEI-NEMA Standards for Watthour Meters, a report of the Joint Committee of the Association of Edison Illuminating Companies, Edison Electric Institute and the National Electrical Manufacturers Association, is now available at 50 cents a copy. The report has two sections, one on general standards, the other on standards applicable to single stator watthour meters.

American Welding Society, 33 W. 39 St, New York 18, has just issued Nondestructive Testing Symbols, prepared by its committee on Nomenclature, Definitions and Symbols. Price is $1, number is AWS A2.2–58. This standard supplies a long-felt need. For the first time it is possible to specify in a single symbol the type of test required. Also, nondestructive testing symbols can be combined with welding symbols.

At work on standardization for dynamic test procedures, Instrument Society of America has issued the initial portion of a new Recommended Practice. It contains general recommendations applicable to all dynamic response test work. This portion is to be followed by four others which will deal in detail with the dynamic testing of specific types of instrumentation. The Society's address is 313 Sixth Ave, Pittsburgh 22, Penna.

● SEVERE OVERSPEEDING followed by disintegration of the shaft and disks is thought to have been the cause of failure of one of the turbines in Calder Hall "B" station in England. The machine was undergoing testing when the shaft broke into several pieces which came through the cylinder walls and were hurled out of the turbine hall to distances as much as 500 yd. No one was injured and fire presumably caused by ignition of lubrication oil was quickly brought under control. The other three turbines in the station were not damaged, and temporary repairs to the building made it possible to restart the reactor in a few days.

● NATIONAL SAFETY COUNCIL'S 46th national congress will be held in Chicago, October 20–24. Congress headquarters is the Conrad Hilton Hotel. The 300 sessions will cover all fields of industrial safety, from the aeronautical industries to wood products.

WOULD YOU LIKE TEAR SHEETS?

Readers wanting tear sheets of any article appearing in the issue for their personal file may obtain them by indicating the item desired on one of the post cards appearing in this issue—Editors.

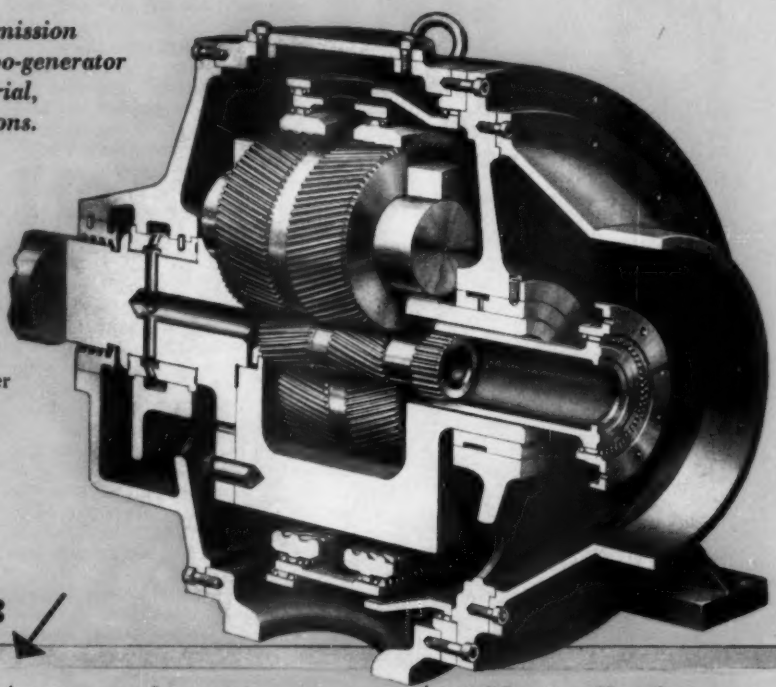
DE LAVAL-STOECKICHT
PLANETARY GEAR

...for high speeds...high horsepower

Proved in hundreds of installations abroad totalling over 3,000,000 horsepower—now available in America!

For all high torque power transmission applications such as pump turbo-generator and compressor drives in industrial, municipal and marine installations.

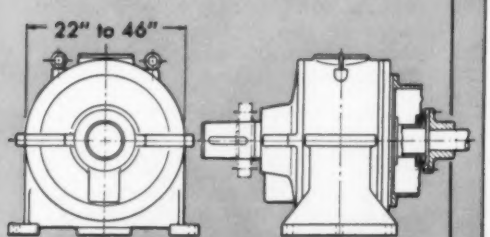
This cutaway view of the De Laval-Stoeckicht Planetary Gear shows how it provides flexibility for proper load distribution throughout the gear members. The thoroughly proved and tested design is completely reliable in transmitting high horsepower for high speed applications. • Highest efficiencies (98% or higher)... no high speed bearings... less friction losses.



Check These Advantages:

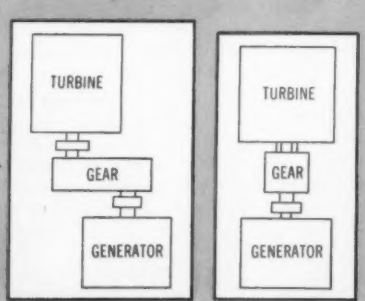
Small Size—Light Weight

Compact—low weight per hp. Sizes range from 22" to 46" in diameter, depending on horsepower requirements. Example: 5000 hp planetary unit weighs 1700 lbs. against 6000 lbs. for conventional gear.



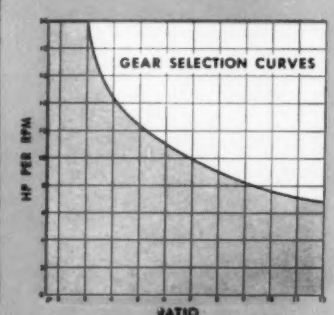
Convenient Arrangement

Co-axial or "in-line" arrangement of gear members takes up far less space than parallel axis gears of equivalent horsepower rating.



Wide Application

Capacity range shown in shaded area on chart below. For other applications, contact your De Laval Sales Engineer.



For further details, write for Bulletin 2400.

DE LAVAL *Steam Turbine Company*

816 Nottingham Way, Trenton 2, New Jersey

WHAT THEY TELL US

▶ **FLY ASH REINJECTION** item in this department in July (from A. H. Gesell) has drawn fire from M. J. Churchill of Detroit Stoker Co. Churchill writes us:

> The first item in your July department starts off with the statement, "Reinjection of fly ash, in most plants, will not improve efficiency but in fact will lower it."
>
> We cannot let this go unchallenged. Although we have no way of knowing about the equipment and operation at Mr. Gesell's plant, we do know from experience with hundreds of Detroit spreader stoker installations, that there is a definite advantage efficiency-wise in returning fly carbon to the furnace for burning.
>
> Naturally there is a variation in results depending on the type of stoker, whether intermittent or continuous ash discharge, and the characteristic of the fuel being burned, and the load; but we can safely say that an increase in efficiency of from 1 per cent to 3 per cent can be expected when a properly-designed cinder-return system is used with spreader stokers.
>
> Tests made with and without return from dust collectors have in some instances shown even greater efficiency increases. In fact, the recapture of the fly carbon is one of the contributing factors to the generally higher efficiencies obtained with spreader stokers than with other firing methods.

What experience have readers had with fly carbon (fly ash) reinjection? Let's have it.

▶ **ON THE SOUTH WALL** of Wisconsin Electric Power Co's East Wells St Station in Milwaukee, is a plaque which states:

> In this station pulverized coal was first successfully burned continuously and at high efficiencies in furnaces of stationary steam boilers, November 11–15, 1919. This radical departure from conventional firing methods of the period was vigorously opposed by some engineers during its early stages. It soon met with local, national and international acceptance, and has resulted in great benefits to mankind through reduced cost of electric power and conservation of fuel resources.

This plaque was a gift to the company, not long ago, by the Wisconsin State Historical Society.

Writing to the Milwaukee *Journal* on this subject, Fred C. Dreyer says:

> In 1915, as an efficiency man for the Milwaukee Solvay Coke Co, I undertook the job of disposing of vast amounts of what is called "coke breeze," a very fine coke dust that is the result of quenching the hot coke as it is pushed out of the ovens.
>
> To dispose of the stuff it was shoveled into a furnace by men with large scoop shovels. It was necessary to carry such a great draft under the boiler that the men shoveling in the "coke breeze" did not get much respite. As a result it was almost impossible to keep anyone on the job.
>
> It was then that I got the idea of injecting the stuff into the fire with the aid of compressed air, and after several months of experimenting finally got the job licked. To the best of my knowledge this was the first time coal was used in this manner, and after all coke is coal.

▶ **ANOTHER HISTORICAL MARKER** of more than passing interest to power engineers is the plaque commemorating America's first commercial installation of the alternating current system. This installation took place in Buffalo, N. Y., on November 26, 1886.

The plaque was presented during AIEE's Summer General Meeting in Buffalo in June. Recipient was the Adam, Meldrum & Anderson Department Store Co, Buffalo, in whose department store the a-c system was installed.

This historic system used George Westinghouse's perfected transformer, which helped set the stage for the world's first economical long-distance transmission of electric power (10 years later, between Niagara Falls and Buffalo).

A. C. Monteith, vice president of Westinghouse Electric Corp, was the principal speaker at the Buffalo presentation. Vividly describing the background of the work of George Westinghouse and William Stanley in perfecting the a-c system, and speaking as though he were in the 1880's, Monteith said in part:

> In Pittsburgh, in January [1886], Mr. Westinghouse has formed a new company to build alternating current equipment. The first system is finished by the autumn of the year. It is successfully tested over a distance of four miles. All the company and Mr. Westinghouse need now is someone with enough faith and vision and courage to buy and install and use this new and unknown system.
>
> The first customer is found in Buffalo. The proprietors of the department store, Adam, Meldrum & Anderson, are interested in the system. On October 3, 1886, they signed a contract to change their lighting from gas to electric. It is the first of its kind ever written.
>
> Now Mr. Westinghouse needs a generating station and lines to carry the power to the A.M.&A. store. He approaches the Brush Electric Co. Brush is the leading supplier of direct-current electricity. But the men at Brush have courage and vision, too, and they agree to assist. A single-phase alternating generator is installed in the Brush Electric Co. A transformer is installed in the store. A lighting system is erected in the store and in the store windows. By November 26 — the day before Thanksgiving — the stage is set for the introduction of alternating-current electric lighting to the United States on a commercial basis.
>
> The Buffalo installation stands as a symbol for an industry and a profession that — from its first year and for three-quarters of a century since — has been built around research and has been keyed to constant, unremitting improvement in its machines and methods.
>
> As a result of this attitude toward technological change, the electrical industry in the U. S., with that of Canada, produces one-half of the electric power generated in the world today.

▶ **ENGINEER** is a title of distinction in the life of the Azores. Dick Morris and Bob McCaw, POWER ENGINEERING'S editorial director and managing editor respectively, recently made a tour of the U. S. Air Force power plant installations in the Islands, and as Bob McCaw reports:

> We had met some of the state officials in the capital of Angra. One of these men was the Director of Public works. We noticed that he was being addressed by the Public Affairs Officer from the Air Base as "Engineer." Later we found that this title is used to carry the same distinction as doctor, governor, and the like.

▶ **THE NEW LOOK** at continuous blowdown featured in the May issue, pages 72–73, caught the weather-eye of the Department of the Navy, Bureau of Ships. Wrote the Bureau, from Washington, D. C.:

> Your article, A New Look at Continuous Blowdown, was of particular interest to the Boiler Section of the Bureau of Ships. We have been considering the utilization of continuous blowdown on Naval boilers that supply steam to marine reciprocating engines. These boilers are particularly troublesome because of filter-aid and oil contamination of the feedwater.
>
> We would appreciate information as to the size and weight of continuous blowdown installations that could be designed to operate 250 psi, 450 psi, 600 psi and 1200 psi.

"And for extreme pressure and temperature there is a heavy duty Armstrong"

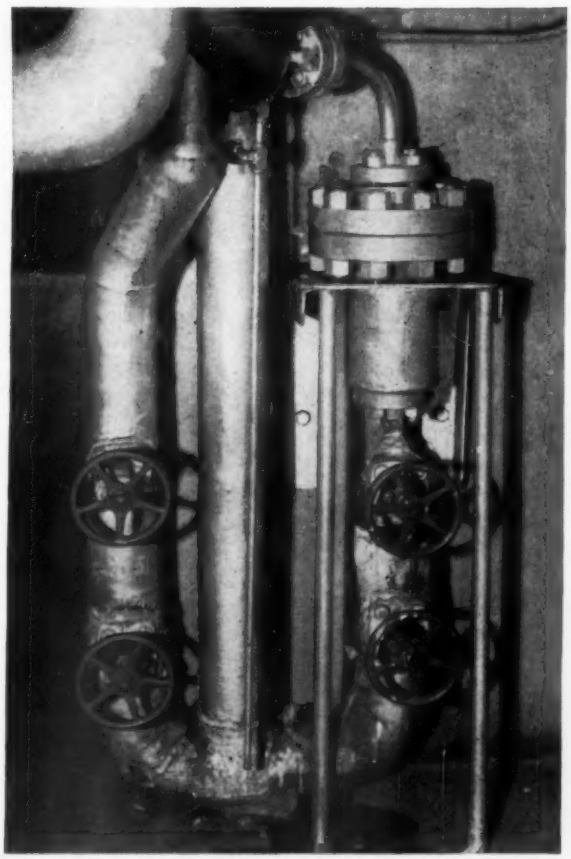
Reproduction of Armstrong Trap advertisement which appeared in power magazines in 1924.

Armstrong steam traps have grown up with the increase in steam pressure that started right after World War I. Forged carbon steel bodies made their debut in 1929 with carbon moly and chrome moly steels following as pressures went up.

The traps listed below have forged carbon steel bodies and caps for service to 600 psig, 750F.; carbon moly or chrome moly to 900 psig, 900F.; chrome moly to 2500 psig and temperatures above 900. Valves and seats heat treated chrome steel or Stellite. Other working parts are 18-8 stainless except the bucket weight.

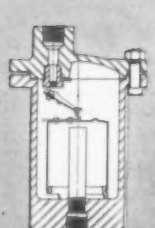
COMPLETE DATA in 44 page CATALOG J, free on request. Call your local Armstrong Factory Representative or write:

ARMSTRONG MACHINE WORKS
8104 Maple St., Three Rivers, Michigan

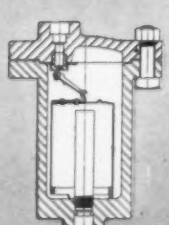


No. 515 Armstrong flanged trap at central station—dependable protection of superheated steam lines.

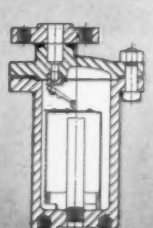
SCREWED, SOCKET WELD AND FLANGED CONNECTIONS



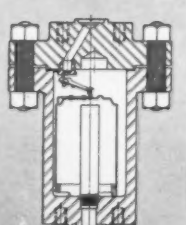
Screwed ½" to 2"—pressures to 900 lbs.



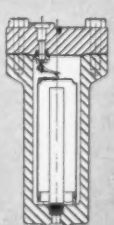
Socket weld ½" to 2" pressures to 900 lbs.



Flanged connections —½" to 2" pressures to 900 lbs.



No. 515 trap—socket weld or flanged 1" or 1¼"—pressures to 1500 lbs.



No. 615 trap—socket weld or flanged 1" or 1¼"—pressures to 2500 lbs.

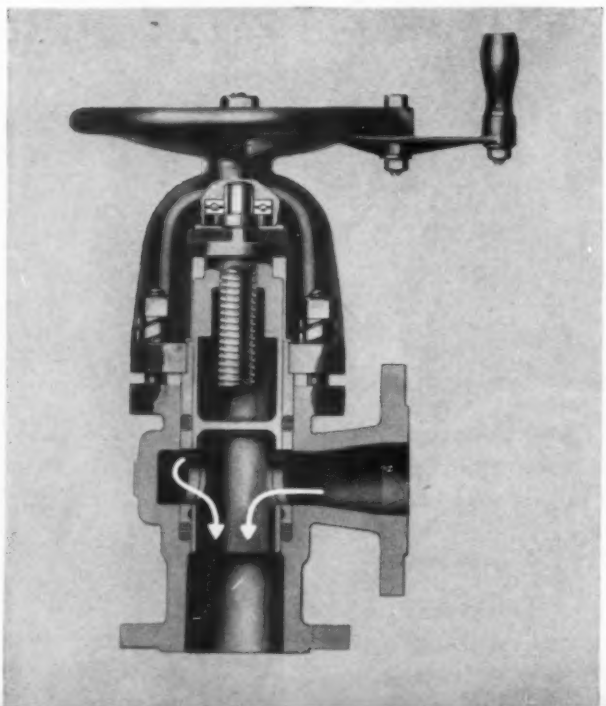
ARMSTRONG INVERTED BUCKET FORGED STEEL STEAM TRAPS

For more data circle 504 on Post Card

These YARWAY VALVE DESIGNS

YARWAY SEATLESS

Features balanced nitralloy hollow plunger that seals line drop-tight, yet permits free, unobstructed flow in blow-down. Other features —laminated packing, alemite lubrication, ball thrust bearings. USED SUCCESSFULLY IN OVER 15,000 BOILER PLANTS.



FOR LOW and MEDIUM PRESSURES

YARWAY HARD-SEAT

Features tough, stellite-faced and ground disc and seat ring, mated to provide smooth long-wearing surfaces. Stream-line flow. Alemite lubrication. MORE THAN 4 OUT OF 5 HIGH PRESSURE BOILER PLANTS USE YARWAY BLOW-OFF VALVES.

FOR HIGHER PRESSURES

USED IN OVER 15,000 BOILER PLANTS

serve every boiler blow-down need

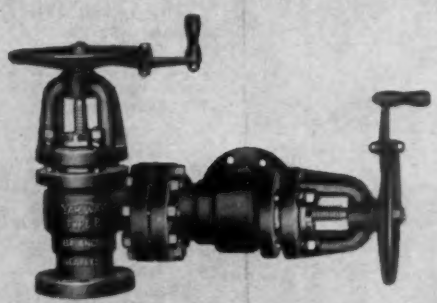
■ Whatever your *pressure* requirement, whatever your *piping* requirement—there's a Yarway Blow-Off Valve to exactly meet your needs.

Popular Yarway *seatless* design keeps blow-down lines drop-tight in low and medium pressure ranges. Sturdy Yarway *stellite seat and disc* design protects higher pressures.

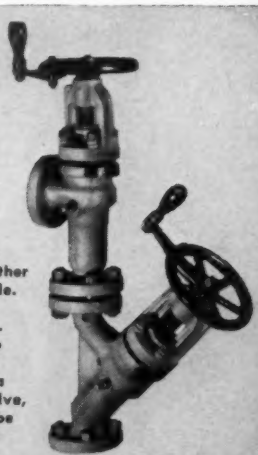
All Yarway Blow-Off Valves are strong, rugged valves, built to withstand the punishment of regular or emergency blowing-down under full boiler pressure, and are available in metals that stand up under acid washing of boilers.

Write for new Yarway Blow-Off Valve Bulletins—B-426 (pressures to 400 psi) or B-434 (pressures to 2500 psi).

• Yarway Type B Seatless Blow-Off Valve, iron body for boiler pressures to 200 psi, steel bodies, for pressures to 400 psi. Angle valve shown, straightway available. Flanged connections. See Bulletin B-426.



• Yarway Type B Seatless Tandem Blow-Off Valve combining two angle valves. Other combinations available. Iron bodies for boiler pressures to 200 psi, steel bodies for pressures to 400 psi. See Bulletin B-426.



• Yarway Type C Seatless Tandem Blow-Off Valve combining angle and straightway valves. Other combinations available. Flanged or welding connections available. For boiler pressures to 600 psi. NOTE: When used in tandem with a Yarway Hard-Seat Valve, Type C Seatless may be used to 1500 psi. See Bulletin B-434.

• Yarway Hard-Seat Blow-Off Valve for pressures to 2500 psi. Straightway valve shown. Angle available. Welded (shown) or flanged connections. See Bulletin B-434.

• Yarway Hard-Seat—Seatless Balted Tandem Blow-Off Valve. Hard-Seat is the blowing valve, seatless is the sealing valve. Available in any combination of connections. For pressures to 1500 psi. Hard seat-hard seat tandems for pressures to 2500 psi. See Bulletin B-434.

• Yarway Unit Tandem Blow-Off Valve. Combines a hard-seat blowing valve and a seatless sealing valve in one-piece forged steel body for boiler pressures to 1500 psi. For pressures to 2500 psi, two hard-seat valves are combined. See Bulletin B-434.

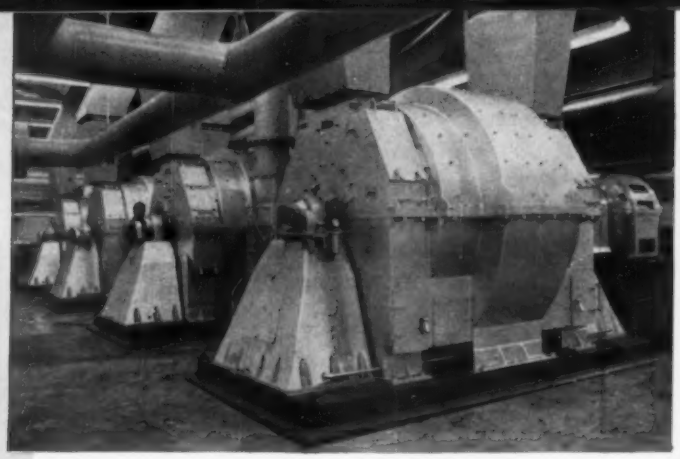
LET YARWAY HELP SOLVE YOUR BOILER BLOW-DOWN PROBLEMS!

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY

blow-off valves

Latest model Riley #350 Pulverizer with Metering Coal Feeder which has a magnetic separator to remove metals escaping the conveyor magnets.



Four Riley 550 Duplex Pulverizers installed in the Picway Station of Columbus & Southern Ohio Electric Co. — one of the many Public Utilities that are using Riley Pulverizers.

The Quiet, Vibrationless RILEY PULVERIZER is

You will not only appreciate its quiet, vibrationless operation but ALL OF THESE OTHER ADVANTAGES:

Dependability

Riley "50" Series Pulverizers are rugged in construction, simple in design concept. All moving parts are on a single shaft rotating on two main bearings. They require no worm gears or other complicated mechanisms. A high degree of selectivity of rejection of foreign material prevents damage to pulverizer parts.

Sustained High Fineness

Tungsten Carbide faced pulverizing elements last for years providing a high degree of pulverized coal fineness.

No Loss of Capacity With Wet Coals

Flash drying in crusher-dryer section evaporates all free moisture. Coal can be dripping wet when entering feeders without loss of capacity. Adequate primary air temperature is provided.

Extreme Load Ranges

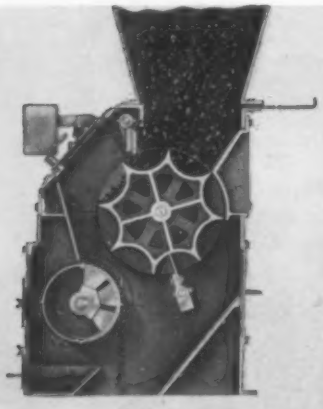
There is no lag with Riley Pulverizers to conform to load changes. Change in feeder rate gives instantaneous change in pulverized coal output.

No Adjustment Necessary to Maintain Fineness

Riley Pulverizers need no springs or other wear compensating devices which require shutdown for adjustment.

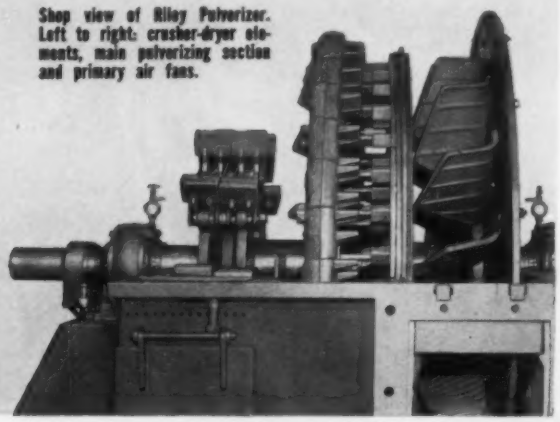
A Minimum Labor Cost in Removing Rejections

Tramp metal and other foreign materials are easily removed thru a door in the crusher-dryer section and thru one in the feeder.

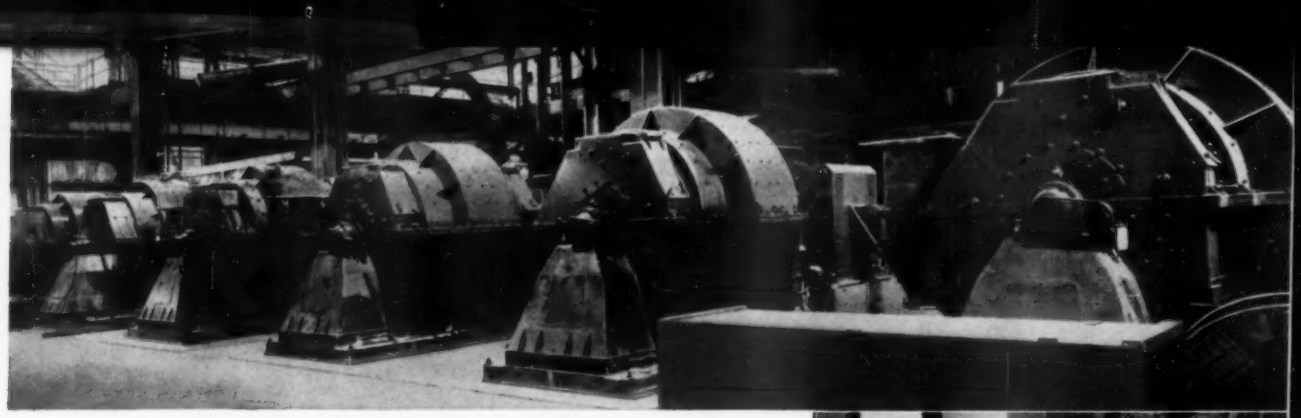


Cross section of Riley Feeder shows how coal is metered and the new magnetic separator.

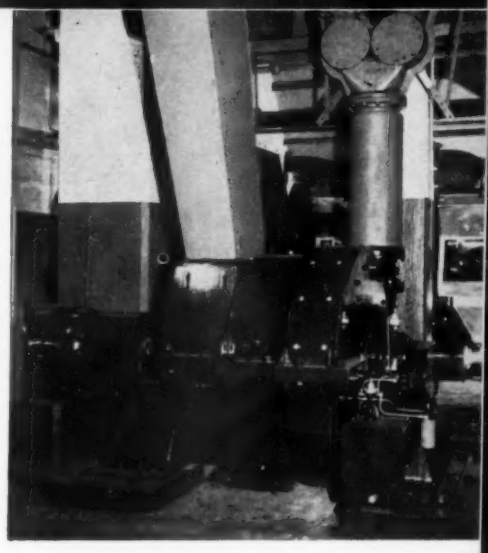
A tungsten carbide faced pulverizing element. Note how carbide completely protects the base.



Shop view of Riley Pulverizer. Left to right: crusher-dryer elements, main pulverizing section and primary air fans.



These six Riley Duplex Pulverizers will supply a 2,000,000 lbs/hr reheat unit at the River Rouge Plant of Detroit Edison Company.



A small #350 Riley Pulverizer installation, typical of hundreds that are operating in industrial power plants with units ranging in capacity from 50,000 lbs/hr up.

Easy on the Nerves!

Ease of Maintenance

All Pulverizer parts are accessible by simply removing top half of housing. Complete replacement of parts can be made in one day. Crusher-dryer parts can be replaced by merely removing separate covers in housing. Bearings for main shaft are only parts to be lubricated.

Ability To Run Without Coal

Because no moving parts are in contact with each other, no damage will occur when operating without coal. Operation is quiet.

Explosion Proof

There has never been an explosion in a Riley Pulverizer under normal operating conditions. Coal travels so fast thru pulverizer that flame can't propagate.

High Primary Air Temperatures Used

Riley Pulverizers operate with discharge temperature normally at 200 F which increases boiler efficiency. Higher temperature aids combustion and lighting of burners.

Ease of Automatic Regulation

Only two adjustments are needed with change of load; (1) coal feed to pulverizer and, (2) air to burners — ideal for efficient automatic operation.

No Auxiliary Air for Sealing

Auxiliary blowers for sealing or for protection of bearings are not required.

Compact and Space Saving Design

Riley Pulverizers occupy the least space per ton capacity of any pulverizer made.

Low Foundation Cost

With no inherent vibration and being the lightest in weight per ton capacity, the foundation does not need to be massive and deep.

Low Power Consumption

Due to the principle of pulverizing in suspension by impact and attrition, power to run Riley Pulverizers is low at all loads.

Ease of Start-Up

The small percentage of primary air, and a uniform distribution of coal from Riley Burners make lighting of burners easy and provide a stable flame at low loads.

Capacities from 3000 lbs/hr to 60,000 lbs/hr

Riley Pulverizers are supplied in a range of capacity suitable for any size of modern boiler.

RILEY

STEAM GENERATING & FUEL BURNING EQUIPMENT

For Complete Riley Pulverizer Details Contact a Riley Office in:

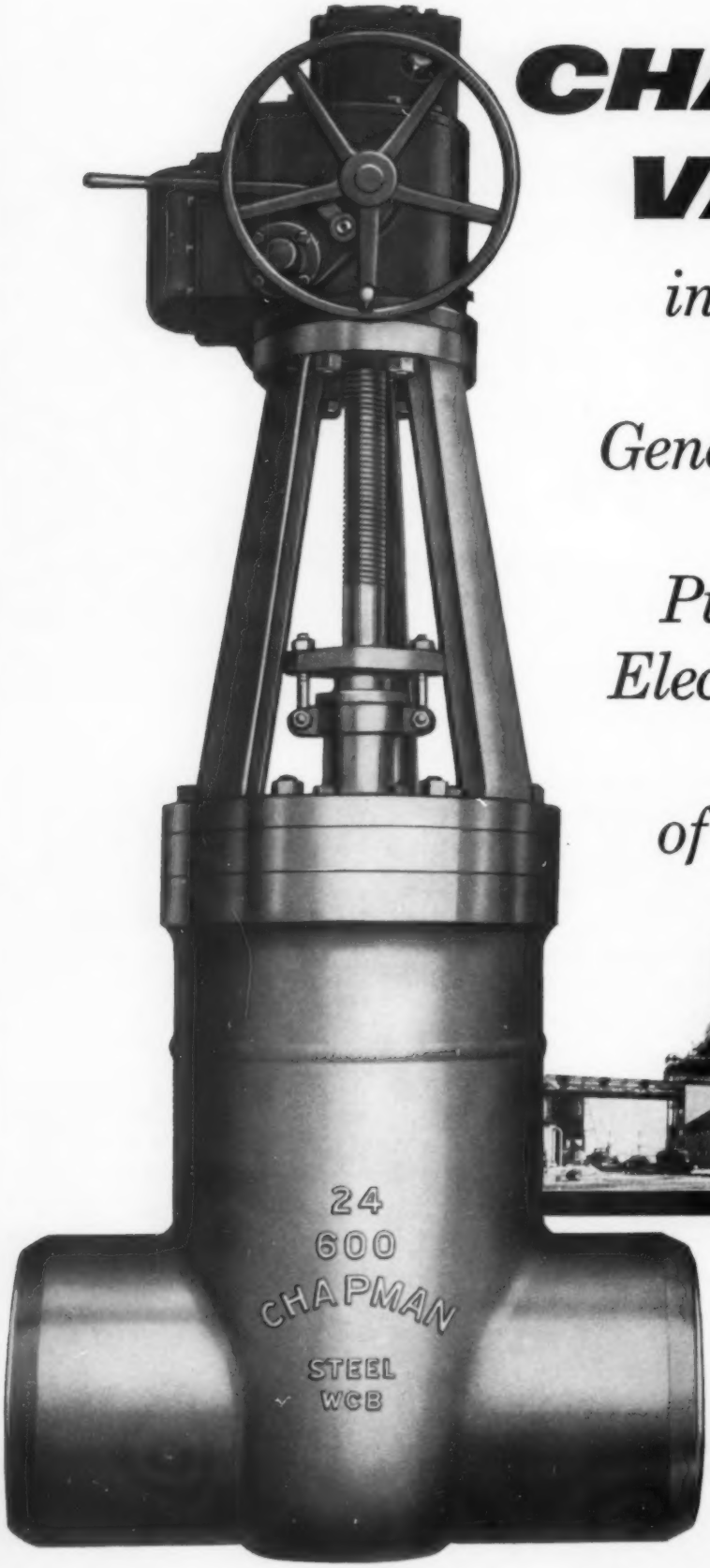
Worcester, Atlanta, Charlotte, Chicago, Cincinnati, Cleveland, Detroit, Houston, Kansas City, Los Angeles, New York, Philadelphia, Pittsburgh, New Orleans, Portland, St. Louis, St. Paul, Salt Lake City, San Francisco, Seattle, Syracuse.

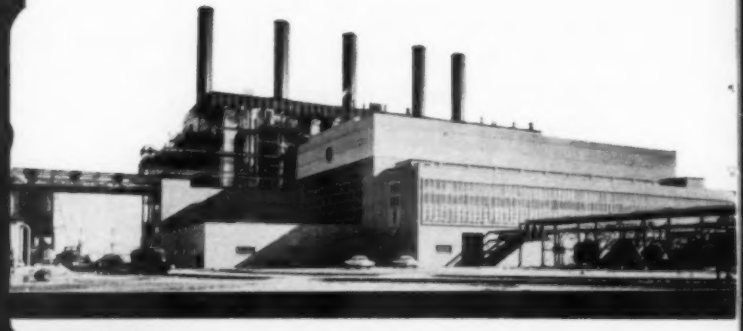
For more data circle 506 on Post Card

Keeping step with a forward step

CHAPMAN VALVES

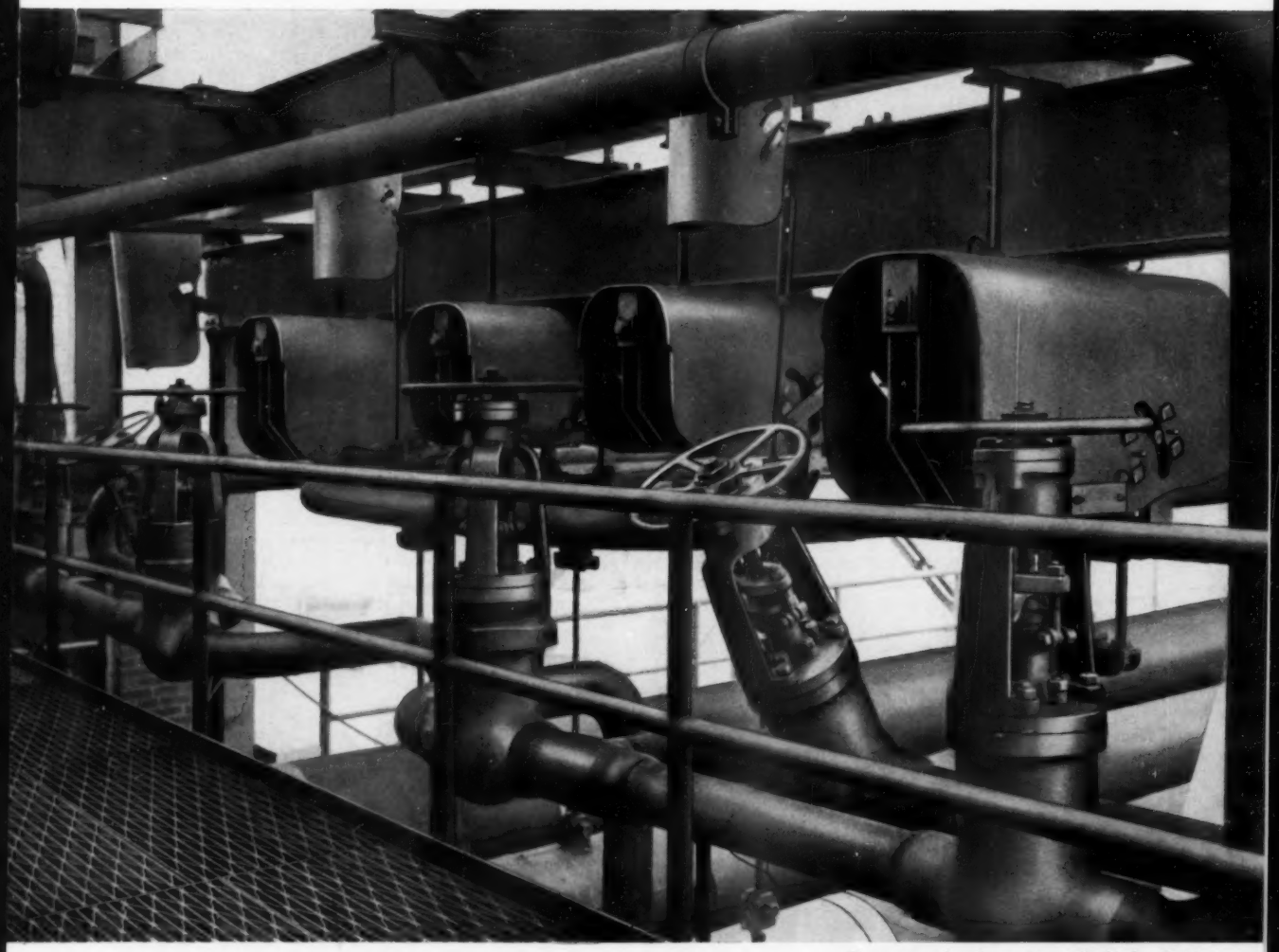
installed in the Linden Generating Station for the Public Service Electric and Gas Company of New Jersey





A Chapman high pressure alloy steel gate valve of the type specified for Linden. This valve has pressure seal body-bonnet connection, welding ends, and is equipped for motor operation.

in Steam Power Plant Engineering



Chapman valves in service at the Linden Station.

It's new. It's modern. And it's now in operation. The Linden Generating Station represents a forward step in steam power plant engineering. Designed by the Electric Engineering Department of the Public Service Electric and Gas Company, the plant was built by United Engineers and Constructors Incorporated. The size of equipment, the magnitude of the throttle and process flows, and high operating economy were involved. They sought and got lower operating costs with no increase in steam conditions.

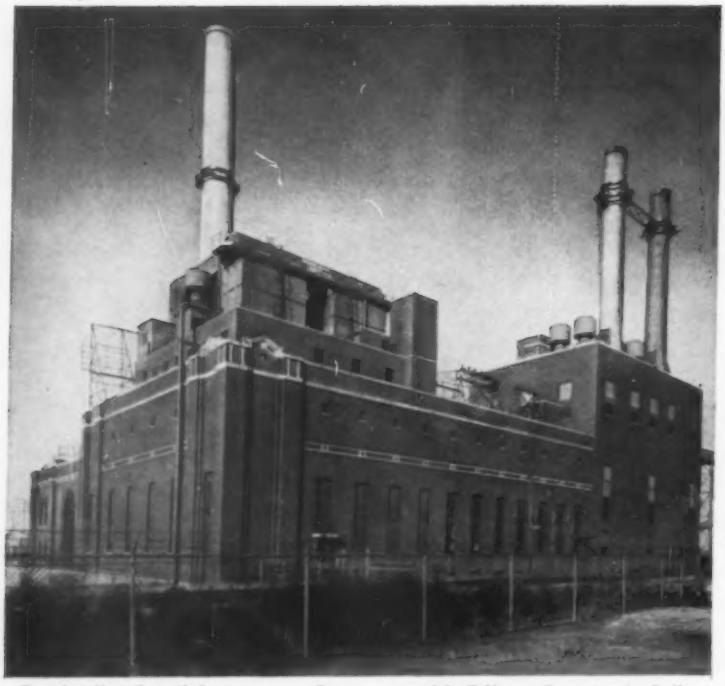
Valves, of course, were also involved. Chapman engineers were prompt to work with the designers and builders of this new station and produce valves that fully met the specific requirements of each application. These included valves for high pressure heater inlets, valves for controlling atomizing steam to desuperheaters, valves for handling high pressure process steam and many others.

No matter what *your* valve requirements might be, it always pays in the first instance and *in the long run*, to talk with a Chapman engineer. Write, and we'll be promptly at your service.

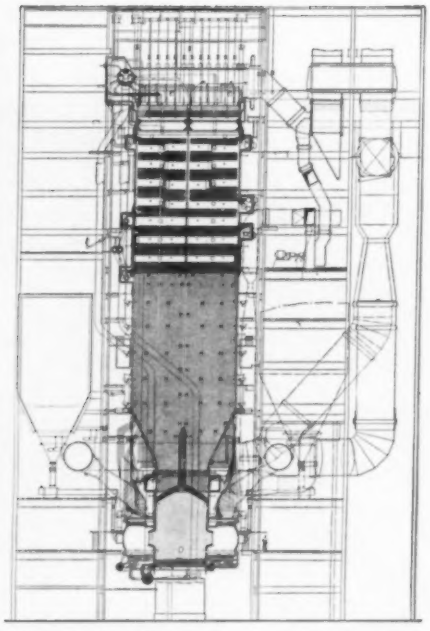
The **CHAPMAN** *Valve Manufacturing Company*

INDIAN ORCHARD, MASSACHUSETTS

For over 75 years, Chapman engineers, metallurgists, manufacturing and testing facilities have concentrated on meeting usual and advanced requirements for power plants, water works, chemical plants, refineries and industrial use.



On the line for eight years at Commonwealth Edison Company's Joliet Station, 2 B&W Cyclone Furnace Boilers produce 1,200,000 pounds of steam per hour.



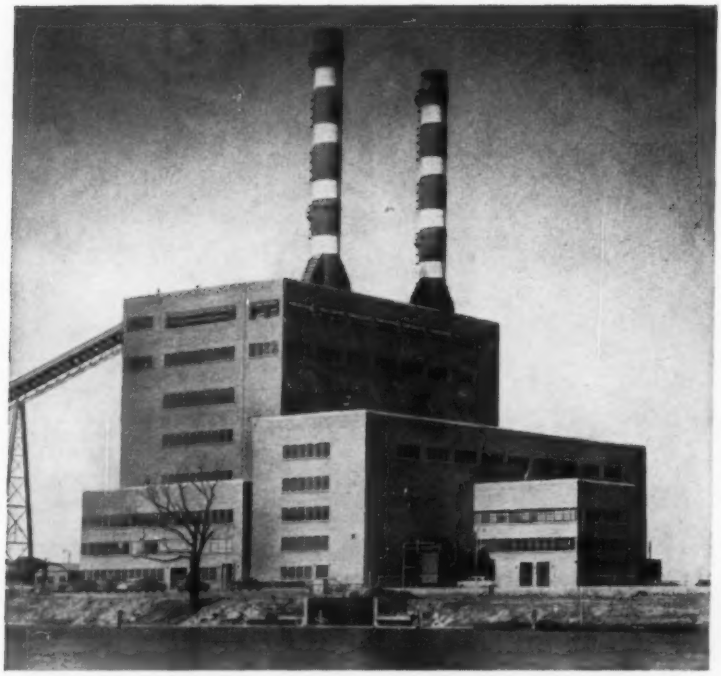
New Cyclone Furnace unit under construction for Joliet Station will generate 2,200,000 pounds of steam per hour. It will burn highly volatile Central Illinois coal with a high ash content and low ash-fusion temperature.

Proof in Action Means Continued Acceptance for B&W Cyclone Furnaces

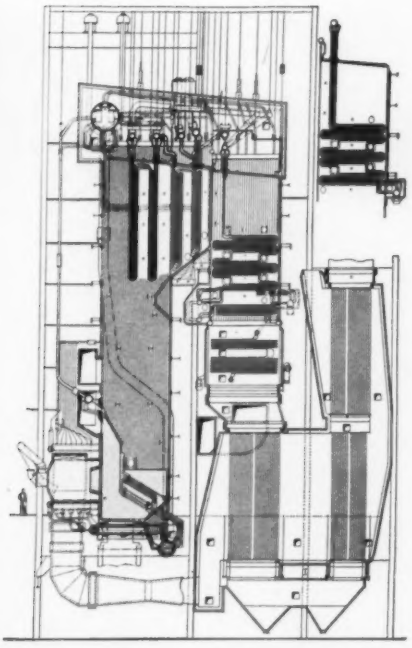
ON-LINE UNITS PROVIDE MODERN MEANS OF BURNING FUEL ECONOMICALLY

In installation after installation, the efficiency, economy and simple operation of B&W Cyclone Furnaces have led to continued acceptance. At the Commonwealth Edison Company, where the first Cyclone Furnace was installed in 1944, 14 additional units are in operation with still another on order. And at Wisconsin Power and Light Company's Edgewater Station, a Cyclone-Fired Boiler achieved such an outstanding record that B&W Cyclone Furnaces were also specified for that Company's Rock River and Nelson Dewey Stations.

The B&W Cyclone Furnace simplifies the entire process of coal preparation, combustion, ash handling and ash segregaton. Its cost-saving quality contributes to lower fuel costs and re-



Rock River Station of Wisconsin Power and Light Company. Six B&W Cyclone Furnaces fire 2 B&W Boilers to produce 1,050,000 pounds of steam per hour.



New unit for Wisconsin Power and Light's Nelson Dewey Station will use a B&W Cyclone Furnace to fire boiler producing 700,000 pounds of steam per hour.

duced maintenance as well as increased operational simplicity, flexibility and safety. Recognition of these facts is attested by the 77 Cyclone Furnace Boilers now either in service or under construction throughout the country.

Many other modern advances in combustion and high-pressure, high-temperature steam generation are also available through B&W. They merit examination in connection with your next installation. Write for further information to The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

PURCHASERS OF THE B&W CYCLONE FURNACE

FOR CENTRAL POWER STATIONS	Number of Cyclone Furnace Boilers
Atlantic City Electric Co.	1
Baltimore Gas & Electric Co.	1
Chilena de Electricidad	2
Columbus & Southern Ohio Electric Co.	2
Commonwealth Edison Co.	16
Consumers Public Power District (Nebraska)	1
Detroit Edison Co.	1
Indiana & Michigan Electric Co.	1
Jersey Central Power & Light Co.	3
Memphis Light, Gas & Water Division	3
Middle South Utilities, Inc.	1
Missouri Public Service Company	2
Monongahela Power Co.	1
Northern Indiana Public Service Co.	3
Ohio Edison Co.	2
Ohio Power Co.	6
Public Service Co., of New Hampshire	1
Tampa Electric Co.	3
United Illuminating Co.	2
Wisconsin Power & Light Co.	4
FOR INDUSTRIAL INSTALLATIONS	
American Cyanamid Co.	1
American Enka Corp.	1
Clinton Corn Processing Co., Division of Standard Brands	1
Columbia Southern Chemical Co.	1
Consolidated Water Power & Paper Co.	1
Dow Chemical Co.	5
Eastman Kodak Co.	1
Greenwood Mills	1
International Paper Co.	4
National Container Corp., of Wisconsin	1
Rhinelander Paper Co.	1
St. Croix Paper Co.	1
Thilmany Pulp & Paper Co.	1
West Virginia Pulp & Paper Co.	1
Total	**77**

BABCOCK & WILCOX

BOILER DIVISION

G-887

For more data circle 508 on Post Card

Solar builds big and small joints for Dresden Nuclear Power Station

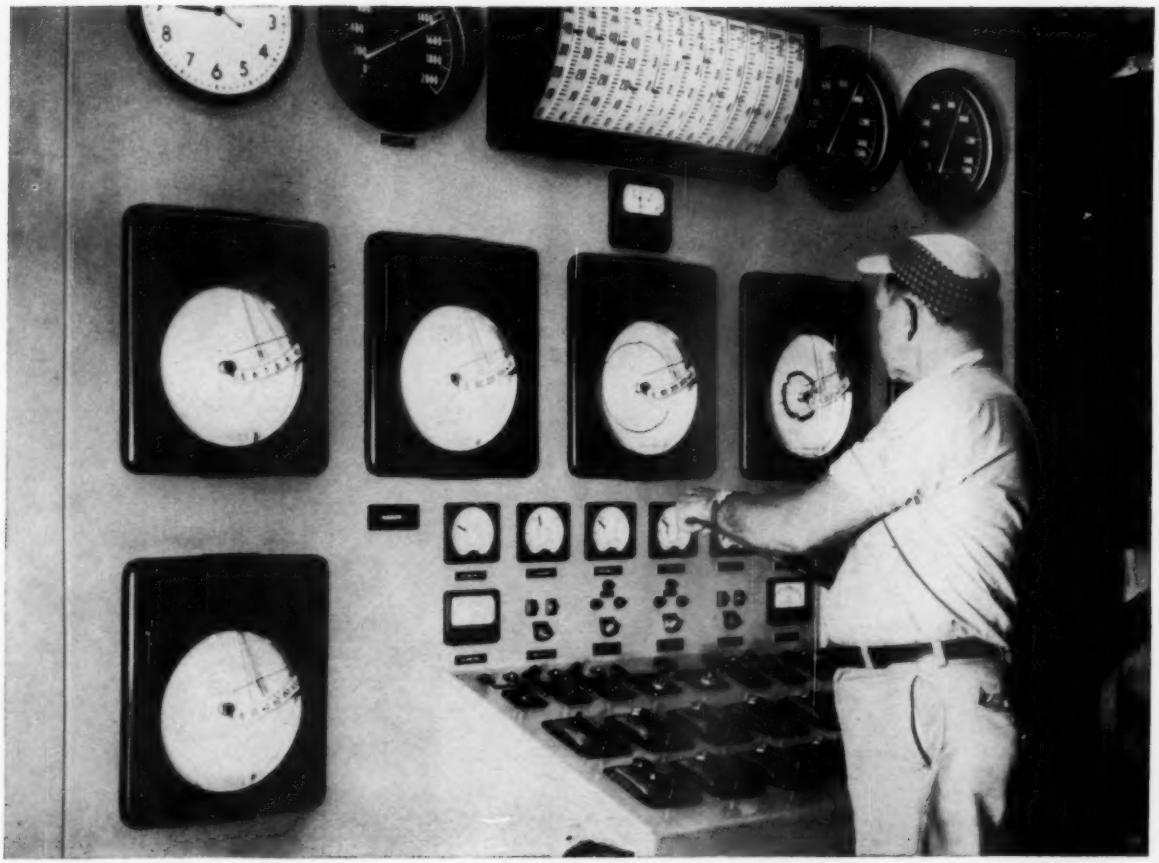
FROM PRECISION BUILT JOINTS ½ in. in diameter . . . to the world's largest . . . Solar offers the *right* expansion joint for every piping need. Shown above are only two of the joints which will go into the $45 million Dresden Nuclear Power Station in Illinois. The larger joint—16 ft in diameter—will absorb differential expansion between a concrete housing and a steel cavity in which nuclear activity takes place. The smaller joint is among several which will serve as a seal on piping for contaminated material.

Solar manufactures the most complete line of expansion joints in the world. They are made from a wide variety of stainless and high-temperature alloys in a complete range of sizes. Temperatures range from −320F to 1200F, pressures from complete vacuum to 600 psi and up. *And rugged, economical Sola-Flex® joints can be "in service" one to four weeks after receipt of order!*

A new pamphlet describes Solar's complete line of Sola-Flex expansion joints. Write for it to Dept. **F-61,** Solar Aircraft Company, San Diego 12, Calif.

SOLAR AIRCRAFT COMPANY — SAN DIEGO DES MOINES

For more data circle 509 on Post Card



Control Room for Cyclone Furnace Boiler at Mathews No. 2 Power Plant of Greenwood Mills, Greenwood, S. C. Bailey MINI-LINE System concentrates controls at operator's station.

How BAILEY simplifies operation of STEAM PLANTS

Your operators can work more efficiently, make adjustments faster when you put Bailey Controls at their finger tips.

Bailey is the choice of virtually all the most efficient plants on the Federal Power Commission's heat rate report.

Here's why:

1. A Complete Line of Equipment

You can be sure a Bailey Engineer will offer the right combination of equipment to fit your needs.

Bailey manufactures a complete line of standard, compatible pneumatic and electric metering and control equipment, that has proved itself. Thousands of successful installations involving problems in measurement, combustion, and automatic control are your assurance of the best possible system.

2. Experience

Bailey Engineers have been making steam plants work efficiently for more than forty years. Veteran engineer and young engineer alike, the men who represent Bailey, are storehouses of knowledge on measurement and control. They are up-to-the-minute on the latest developments that can be applied to your problem.

3. Sales and Service Convenient to You

There's a Bailey District Office or Resident Engineer close to you. Check your phone book for expert engineering counsel on your steam plant problems.

A138-1

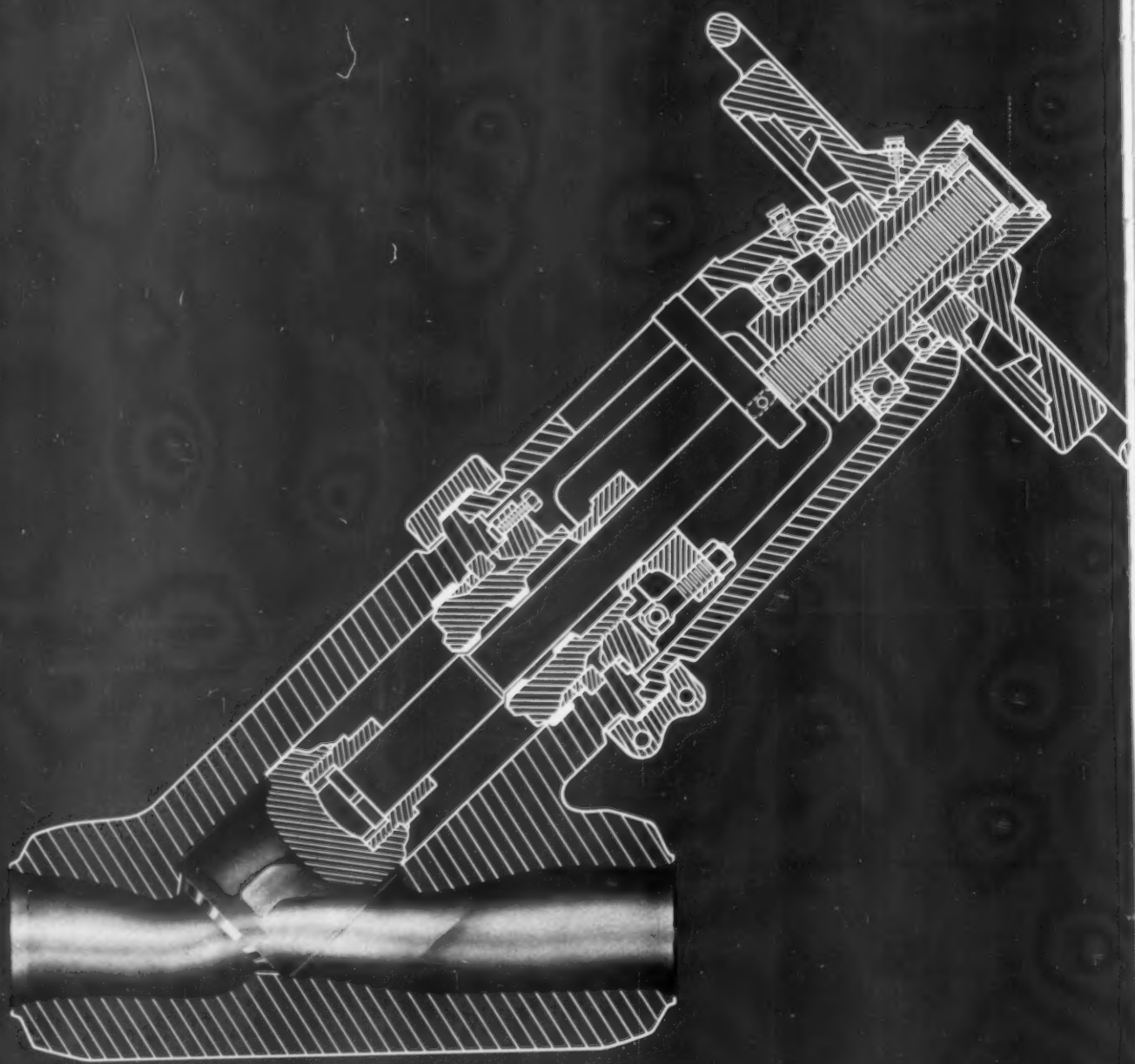
Instruments and controls for power and process

BAILEY METER COMPANY

1040 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

For more data circle 510 on Post Card



NEW EDWARD "FLITE-FLOW" VALVE

What's New from Edward Valves, Inc.

New Products . . . Problems and Solutions. . . Information on Steel Valves from Edward, Long-Time Leader in the Field!

New Flite-Flow* Valve Cuts Pressure Drop 70%

. . . yet provides full globe valve tightness and repairability

Through basic characteristics of its design, only a hard seat globe-type valve can be depended upon to give drop-tight shutoff under high-pressure, high-temperature conditions. But conventional globe valves also produce serious pressure-drop problems—which intensify in the trend toward larger-capacity, higher-pressure plants with their higher-velocity flow rates.

Briefly stated, this was the problem given to Edward engineers. In their continuing program of valve development, these men had singled out turbulence in the flow path as a key area for study. They charted the effects of re-shaping flow passages . . . of shifting valve seat location . . . of *pre*-shaping the flow as it approaches the seat.

Low turbulence factor

All tests confirmed that total pressure drop was least when turbulence was minimized in the three most critical areas: ahead of, at *and beyond the seat.* In the final design, flow approaching the seat is pre-shaped to provide a special "squirting action" which carries the fluid smoothly across the seat. The downstream side of the passage is shaped to receive this flow and send it on with a minimum of eddy and turbulence.

The net result of years of research and development, Flite-Flow is available in sizes 10" and larger.

The result is Flite-Flow, a globe valve with drop-tight shutoff *and* negligible pressure drop, as shown in the tables below:

FEEDWATER SERVICE

In 500-F, 3000-psi feedwater service on a 1,500,000 lb/hr unit, the following performance of 12-inch valves has been recorded:

Ordinary globe valve ... 10-15 lb drop
EDWARD FLITE-FLOW VALVE ... 2.1 lb drop
Good gate valve ... 1.0 lb drop

STEAM SERVICE

In 1050-F, 1900-psi steam service at 800,000 lb/hr through a 12-inch valve, the following performance has been recorded:

Ordinary globe valve...64 lb drop
EDWARD FLITE-FLOW VALVE ... 11 lb drop
Good gate valve ... 2 lb drop

OTHER IMPORTANT FLITE-FLOW FEATURES:

- RESISTANCE TO THERMAL DIFFERENTIALS —a real design and metallurgical achievement.
- REPAIRABILITY OF SEATING SURFACES —while valve is in the line.
- PIPING VERSATILITY —fits any piping plan. Unique design assures accurate guiding of disk whether stem extends up, down or horizontally.
- IMPROVED OPERATING MECHANISMS —manual, pneumatic, electric.
- INTEGRAL SEAT CONSTRUCTION —inlaid stellite seat, machined and lapped in same set-up as body bore for perfect alignment.

EDWARD VALVES, INC.

Subsidiary of ROCKWELL MANUFACTURING COMPANY

1202 West 145th Street, East Chicago, Indiana

Represented in Canada by

LYTLE ENGINEERING SPECIALTIES, LTD., 360 Notre Dame St., W. Montreal 1, Que.

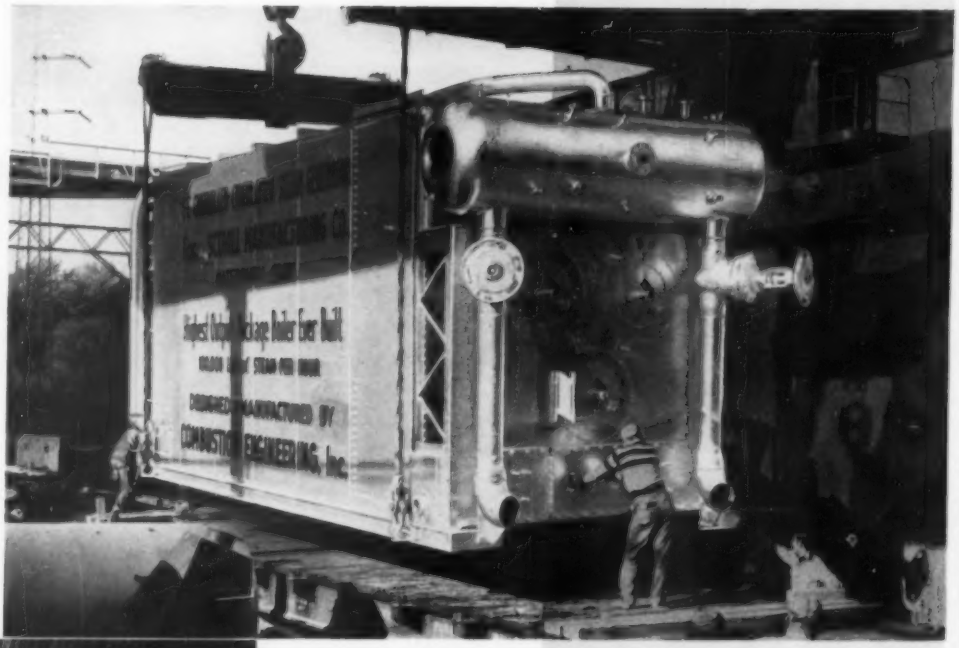
Edward builds a complete line of forged and cast steel valves from ⅛" to 18"; in globe and angle stop, gate, non-return, check, blow-off, stop-check, relief, hydraulic, instrument, gage and special designs; for pressures up to 7500 psi; with pressure-seal, bolted, union or welded bonnets; with screwed, welding or flanged ends.

*T.M. Reg. U.S. Pat. Off.

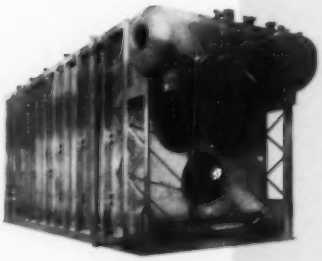
For more data circle 511 on Post Card

Announcing THE C-E CONTROLLED

Another Combustion first in the boiler field — the type PCC package unit, utilizing controlled circulation. This one, being loaded at our St. Louis shops for delivery to Scovill Manufacturing Co., is the world's highest output package boiler, having a design capacity of 100,000 lb. of steam per hr. This picture illustrates the ease with which this new, high performance design can be readied for shipment. Its size permits transfer from railway siding to destination by truck.



Tubing arrangement—looking toward rear through burner opening.



Fabrication view of drum end of 100,000 lb. per hr. type PCC boiler. Three circular openings accommodate burners. Integral structure requires no outside support for boiler.

Rear view of type PCC points up superheater arrangement and complete waterwall construction of this boiler.

CIRCULATION PACKAGE BOILER

...Type PCC

A NEW HIGH PERFORMANCE DESIGN OFFERING

Capacities to 100,000 lb. per hr.
Pressures to 1,000 psi
Temperatures to 900 F.

Available for the first time to industrial steam users is C-E's famous controlled circulation design in a convenient package size. The oil or gas fired PCC offers capacities from 80,000 to 100,000 lb. per hr., pressures from 450 to 1000 psi, and temperatures to 900 F. Higher pressures and temperatures are obtainable if desired.

Seven PCC boilers are now in service. One of these is a special purpose design for steam conditions of 1500 psi and 1050 F.

The PCC is especially suitable where existing space is limited, yet high capacity, temperature, and pressure are required. It is only through the use of controlled circulation that such a compact, high performance unit could be built. This exclusive C-E design assures positive distribution and control of water to all circuits, permitting the PCC to be placed on the line faster than any natural circulation boiler. It also allows easy handling of rapid load swings with high quality steam production.

Not only does the PCC combine outstanding performance in a unit requiring minimum space, but also it offers the inherent advantages of package boiler design: quality shop assembly by experts, better delivery dates, much less plant disruption for installation and, of course, cost advantages due to these features.

If your future steam requirements call for a high performance boiler, it will pay you to investigate the PCC. It offers utility type boiler quality in a compact package along with the economy and reliability characteristic of C-E design.

THE PCC

Meets these industrial steam needs	with these advantages
• Power generation—with or without process steam requirements.	• Controlled circulation
• High capacity, temperature, pressure.	• Quality shop fabrication
• Maximum generating capacity in limited space.	• Ease of shipment • Minimum plant down-time for installation • Earlier delivery than possible with field erection

COMBUSTION ENGINEERING

C-E

C-169

Combustion Engineering Building
200 Madison Avenue, New York 16, N.Y.

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS; PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOR PIPE

For more data circle 512 on Post Card

Looking for cost leaks? Look at your steam traps

Engineering approach to steam trapping can save thousands a year on costs of fuel, trap maintenance, process cycle time, and uniformity of product quality

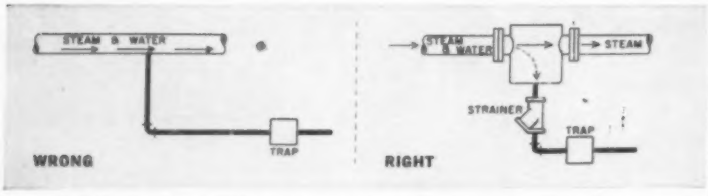
Plant and process engineers all across industry have found that Sarco *Production-Planned* steam trapping can pare operating costs by thousands of dollars a year.

Production-Planned steam trapping is an engineering approach to the problem of getting full design values of heat transfer from steam using equipment. Scores of case histories show that it can make substantial savings and improve processing efficiency. At the same time, costly trap maintenance can be greatly reduced.

In Sarco *Production-Planned* steam trapping, traps are matched to the job by *type* as well as size. They are properly placed, correctly installed. And, to keep down maintenance and replacement costs, every trap is top-quality.

It may pay you well to take this engineer's-eye view of *your* steam trapping. And why not have a Sarco representative look over your system with you? His suggestions will be completely objective because Sarco—and only Sarco—makes a steam trap for every basic requirement. Quality? Recognized everywhere for half a century.

Production-planned systems make best use of traps



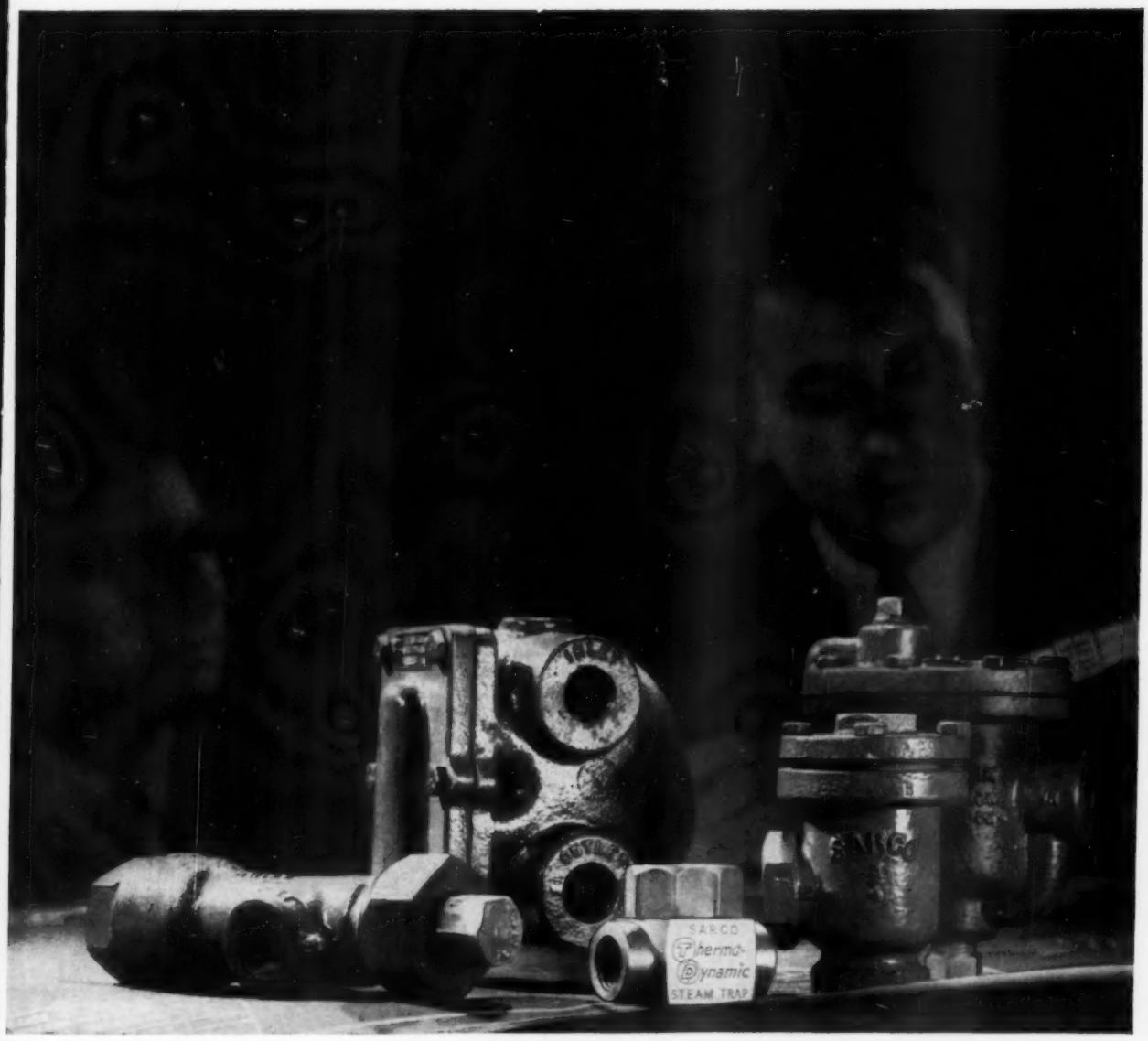
As the two illustrations above show, correct application of steam traps is as necessary as using the right trap. In the hook-up on the left, the lack of a condensate collection point plus the long leg to the trap will result in condensate's flowing past the drain point, possibly causing water hammer. The correct way to install the trap is shown at right, placed close to the drain point. A *strainer* should be placed before *any* trap to prevent entrance of scale or other foreign matter into the trap.

This is just one example of the way your Sarco representative can help you plan your steam system for maximum production.

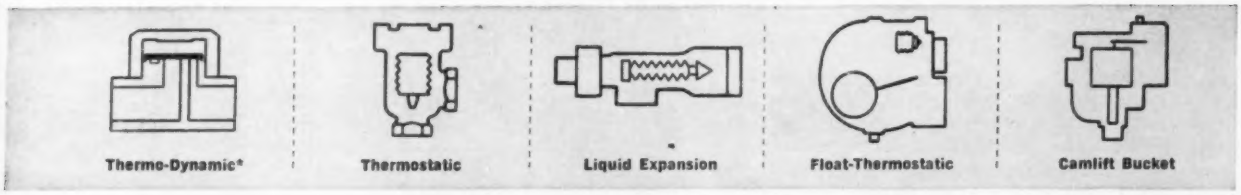
Traps must be matched to job for best system performance

No single type of steam trap will perform well in all applications. Each type has a range of applications for which it is best suited. For optimum efficiency these differences must be taken into account; traps must be chosen for their operating principles as well as their size and pressure rating.

Sarco can give you impartial help in selecting traps because only Sarco makes the five basic types. With Sarco, it's simple —one source, one responsibility, for all your trapping needs.



Only Sarco makes these five basic types of steam traps



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Take these two steps to Production-Planned steam trapping:

(1) Write today for Sarco literature; (2) Talk with your Sarco representative. He can help you check your trapping requirements, and he has—or will quickly get—the right answer to any unusual trapping problem.

*T.M.U. Pat. No. 2,817,353.

SARCO

COMPANY, INC.

635 Madison Ave., New York 22, N. Y.

STEAM TRAPPING • AIR VENTING • TEMPERATURE CONTROLS • HEATING SPECIALTIES

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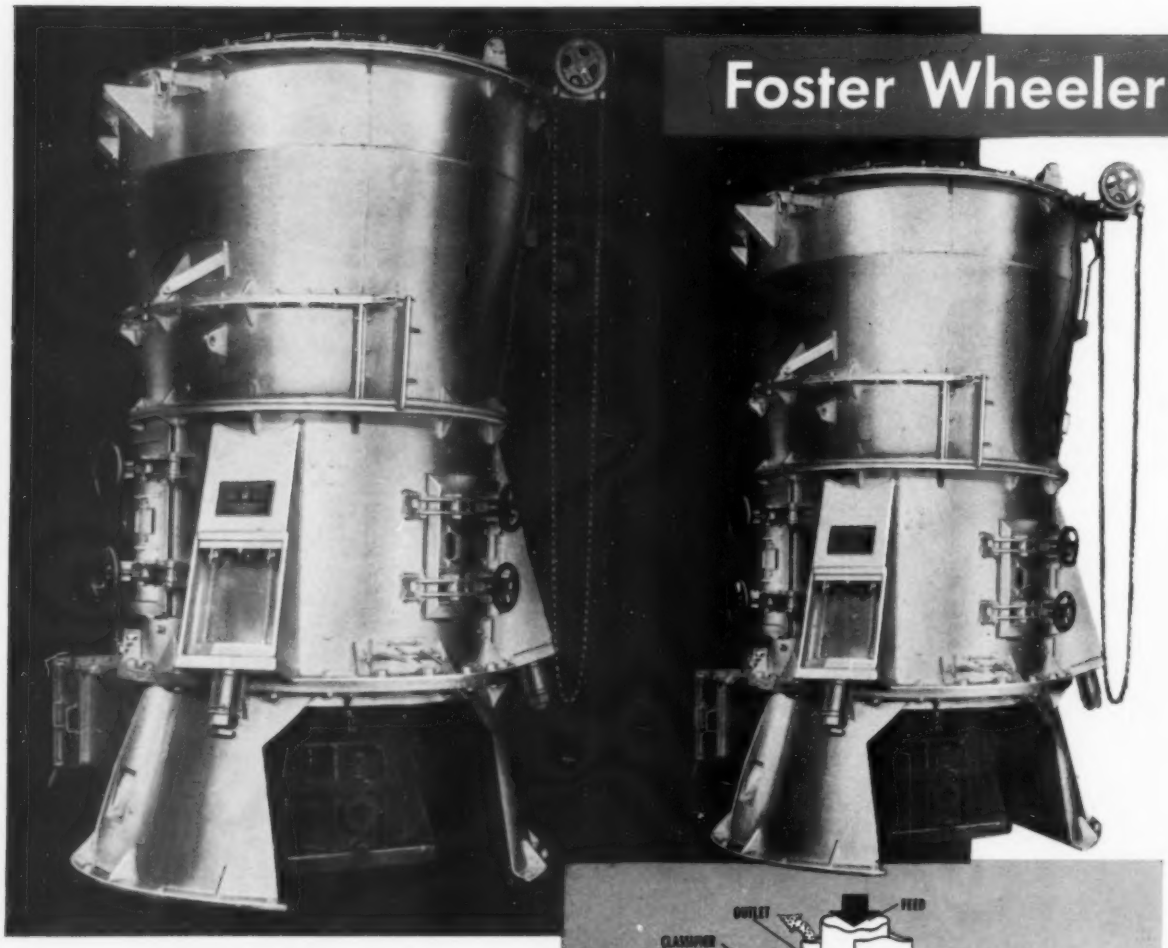
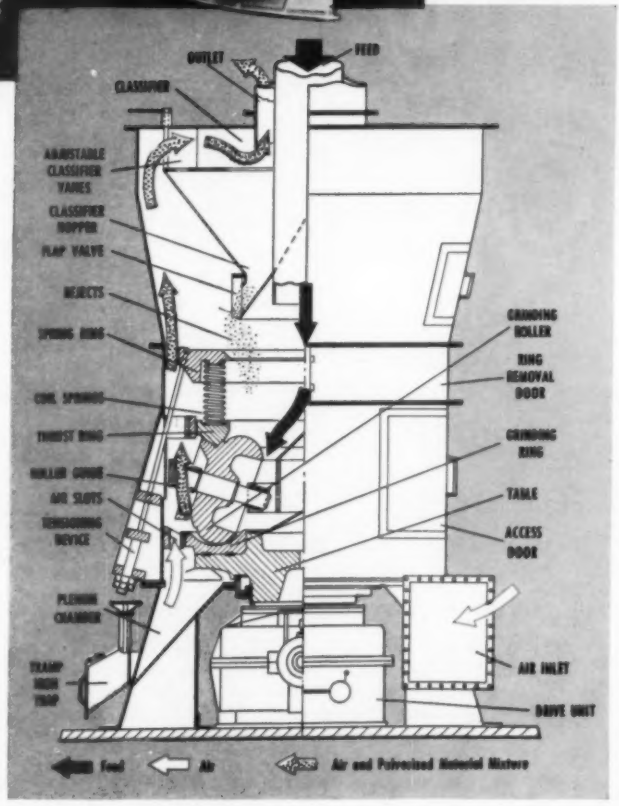


HOW THE MB PULVERIZER WORKS

In the MB Pulverizer, grinding action takes place between a slowly rotating horizontal table and three spheroidal rollers, uniformly spaced around the table and loaded by the adjustable thrust of a large number of heavy coil springs. The power driven table causes the rollers to rotate while circling planet fashion and rolling over the material on the table. The rollers move up and down independently of each other as required to compensate for foreign matter in the charge.

The charge, entering the mill, is fed directly onto the grinding table, where it is crushed between the table and the rollers. Air entering from below the pulverizer table, floats the ground particles up into the classifier, located in the top of the housing. Particles too coarse to be carried to the classifier fall back onto the table for further pulverization. The classified pulverized fuel is discharged through the outlet at the top of the casing.



"MB" PULVERIZERS

offer proved advantages of

LOW POWER CONSUMPTION and LESS MAINTENANCE

Planetary Roll and Table Design, with 9 years of successful operating experience in Europe, now available in capacities up to 60 tons per hour

THE FOSTER WHEELER Type MB Pulverizer is a simple, compact, planetary roll and table mill for pulverizing solid fuels to commercial fineness with exceptionally low power consumption, low maintenance cost and high availability.

Introduced in Europe in 1949, this type of mill has now had nine years of service experience, with excellent performance records and outstanding economy of operation. Its proved advantages, summarized below, can contribute materially to important savings in the cost of pulverized fuel for large or small steam generators.

Low Power Consumption. Efficient grinding action results in unusually low power requirements per ton of capacity, assuring lower operating costs, year after year.

Low Maintenance. Extremely rugged construction and easy accessibility of all wearing parts reduce down-time for servicing. There are no bearings or lubricated parts subject to dust and heavy pressure. Grinding ring and rollers wear *slowly* and *uniformly* and can be easily replaced when required.

Uniform Product Fineness. Throughout the life of the grinding elements, uniform product fineness is readily maintained without loss of capacity.

Pressurized or Suction Operation. With all moving parts enclosed in a stationary, air-tight casing, the MB Pulverizer can be used for either pressurized or suction operation, providing complete flexibility for various types of firing service.

High Availability. All necessary adjustments for grinding pressure and particle size can be made externally while the mill is in operation, avoiding shutdowns except for periodic inspection or overhaul.

The type MB Pulverizer, with Foster Wheeler feeders, distributors, burners and fans or exhausters, provides a highly efficient and economical pulverized fuel system, supplementing the FW line of heavy-duty Ball Mill systems. For complete information, send for Bulletin MB-58-1. *Foster Wheeler Corporation, 666 Fifth Ave., New York 19, New York.*

FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

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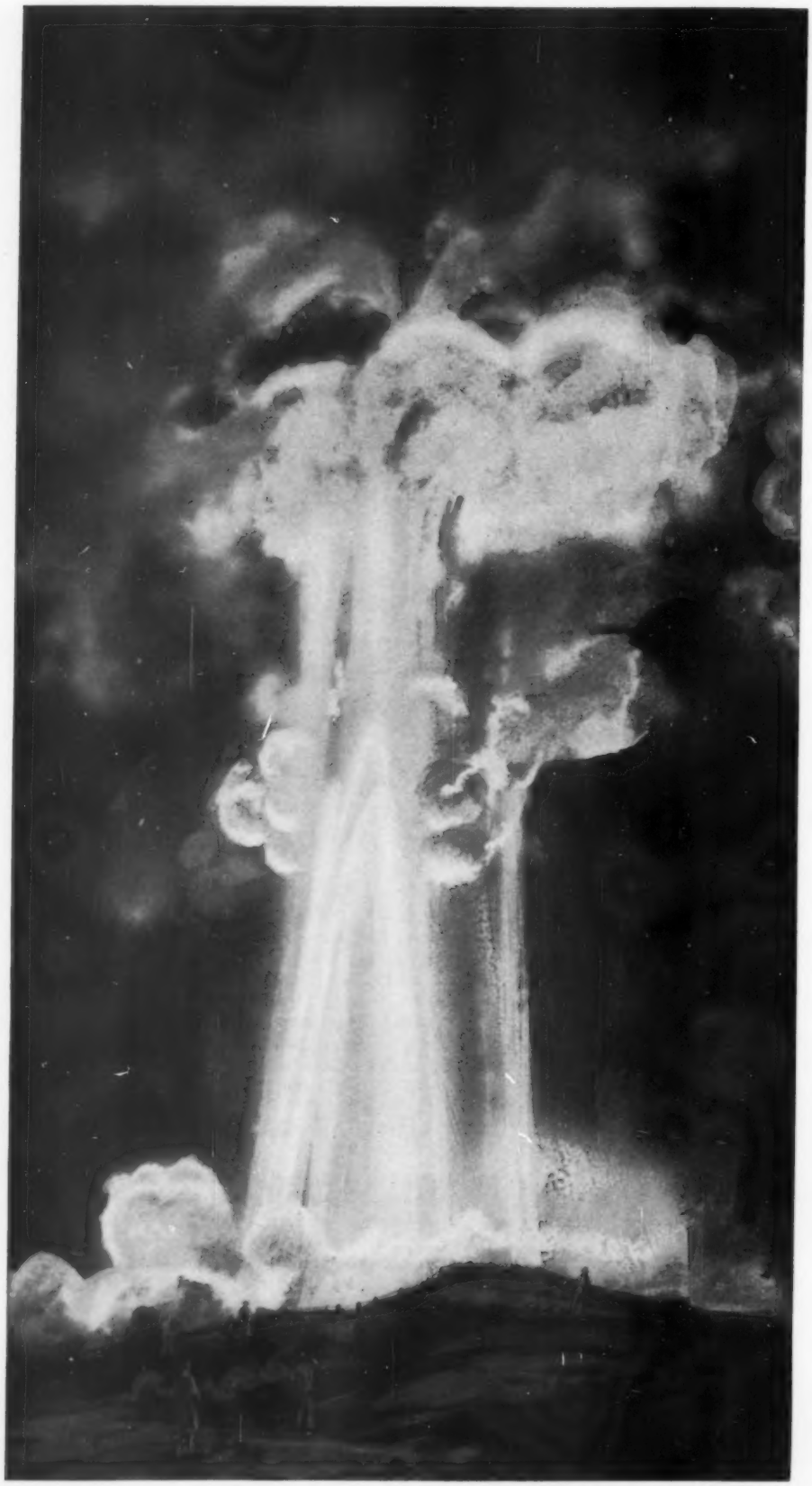

STEAM
...on schedule

Old Ben Coal is the "Old Faithful" fuel for low cost steam when you want it, where you want it. Although more than 200,000,000 tons of this genuine Franklin County coal have gone to market, there's still a hundred-year unmined supply.

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HELPFUL BULLETINS

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Cards provided on pages 121 and 122.

MECHANICAL POWER TRANSMISSION

101 Shaft-Mounted Reducers — Ten-page Booklet B-7238 is an engineering manual featuring selection, horsepower ratings, dimensions, construction, installation and maintenance information for company's shaft-mounted speed reducing units. Illustrated with photos and cutaway views, it describes how to select shaft-mounted reducers considering AGMA service factors for particular applications. Westinghouse Electric Corp.

102 Variable Speed Control — Eight-pp Bulletin F-1882 describes operation and application of Varitrol variable speed drive and pneumatic control systems. Typical applications are illustrated. U. S. Electrical Motors Inc.

103 Roller Chain Drives — Eight-pp Catalog D-58 provides descriptive information, prices and tabular data pertinent to company's line of roller chain drives. Among items described are bushed type and plate sprockets, interchangeable bushings, bushings for larger sprockets, and single strand and double strand roller chains. Maurey Mfg. Corp.

104 Adjustable Speed Drives — Magnetic adjustable speed drives designed for converting alternating current to direct current are described in 14-pp Bulletin EN-65. Includes sketch of operation, illustrations of control and power conversion units, and of components and control stations, as well as tables of sizes and dimensions. Cutler-Hammer, Inc.

105 Helical Gear Drives — Folder 2651-A, a 6-pp catalog supplement, contains complete data on horsepower ratings, dimensions, mounting information and a resume of construction principles applying to the quadruple reduction speed reducers. Also contains information on double reduction and triple reduction helical gear drives. Link-Belt Co.

106 Worm Gear Drive — Eight-pp Bulletin 150 provides useful information on worm gearing in general, points out the advantages of this type of gearing and gives pertinent design and manufacturing facts. Illustrations of typical applications included. The Cleveland Worm & Gear Co.

107 Flexible Couplings — Bulletin 10100A, 8 pp, has been revised to cover new additions to company's line of flexible couplings and includes selection data and other engineering tables. The revised tables also include newly designed couplings with ductile-iron flanges and a special steel retaining ring and specially balanced couplings. T. B. Wood's Sons Co.

108 Flexible Drive Couplings — Described in this illustrated catalog is a line of flexible drive magnesium alloy couplings. Complete specifications, exploded view photos, and cutaway drawings are included. Detroit Power Coupling Co.

DUST CONTROL

109 Cyclone Dust Collector — Bulletin C-958 illustrates and describes design and structural features of high efficiency cyclone dust collectors. Application drawings and illustrations, and a detailed discussion of factors involved in cyclone performance and selection are included. The Ducon Co., Inc.

110 Dust Control System — Twelve-page Bulletin CJ-1 details advantages of dust control through preventive techniques with company's Chem-Jet system. Describes principle of the system which uses a surface-active compound to prevent dust from becoming airborne. Operation, basic techniques, and installation of the system are covered. Johnson-March Corp.

PUMPS, COMPRESSORS

111 For CV Pump Sizing — This nomograph is for sizing chemical feeding systems. To use it, you must know the concentration of the chemical solution to be metered, required chemical dosage, and flow rate of process stream. With this information, you can determine necessary pump capacity and tank holding capacity needed according to refilling period. Nomograph also gives sizes of controlled volume pumps that are 20, 50 or 100 per cent over capacity when these margins of safety are desirable. Milton Roy Co.

112 Pumps, Motors, Valves — Twelve-page Catalog 100 contains basic information on pumps, fluid motors and valves, including internal gear pumps, sliding vane pumps and spur external gear pumps and fluid motors. Includes descriptions of operating principles and internal construction, pump guide selection chart giving operating requirements, construction features, mountings, packing characteristics. Tuthill Pump Co.

113 Industrial Air Compressors — Catalog 37, 20 pp, describes features and advantages of company's industrial air compressors furnished in either two stage or single stage units. In addition to describing operation, catalog also features ratings and data table, working pressure table, vapor chart, and other tabulated engineering data, as well as dimensions, schematic diagrams, and specifications. Brunner Div., Dunham-Bush, Inc.

114 Compressors, Gas Turbines — Composite Catalog 151, 40 pp, features company's line of standard products, highlighting latest engineering and performance data with reference to petroleum, refining, chemical, petro-chemical and other industrial applications. Detailed specifications and diagrams of gas-engine-driven, steam-engine-driven and electric-motor-driven compressors are included. Unit characteristics and application suggestions are also given. Data on vertically and horizontally split multi-stage centrifugal compressors and on gas turbines provided. Clark Bros. Co.

ELECTRICAL

116 Breakers and Enclosures — This 56-pp illustrated catalog contains complete pricing, dimensional and application information on molded case and large air circuit breakers, as well as general descriptions of switchgear products, Tranfo-units and high voltage switching devices. A central selection chart indicates ratings, overcurrent devices, attachments and modifications available on individually-enclosed circuit breakers. Application sections, wiring diagrams and typical applications of each breaker included. I-T-E Circuit Breaker Co.

117 Protective Relays — Featured in 16-pp Catalog 5-020 are time delay overcurrent relays, directional inverse time overcurrent relays, differential relays, instantaneous overcurrent relays (adjustable setting), inverse time voltage relays, auxiliary relays, ac-dc definite time relays, and reclosing relays. For each model, descriptive material, tabular data and photos detail its applications, special features, design, settings, burdens at 60 cycles, contacts, and case. Federal Pacific Electric Co.

118 Control Centers — A line of pushbutton controlled electricenters is illustrated and described in this 8-pp bulletin. Along with descriptive data, it includes wiring diagrams and knockout plans. Bulldog Electric Products Co., Div. I-T-E Circuit Breaker Co.

119 Oil Switch — Bulletin GEA-6554A describes company's Type FKC oil switches for remote and manual operation of capacitor, outdoor lighting and load break applications. Gives detailed information on features, characteristics, construction and operation; includes cutaway drawing, wiring diagrams, and dimensional drawings and rating tables. General Electric Co.

120 Heavy Duty Systems — Features and applications of heavy duty Feedrail for powering cranes, hoists or other moving equipment are detailed in 28-pp Bulletin 70. Includes data on track sections, track accessories, trolleys, rainshields, typical installations, planning an installation, mounting methods — dimensions, photos of installation procedure, and typical specifications. Feedrail Corp.

121 Metal Raceways — Pocket-size Catalog and Wiring Guide 21, 144 pp, covers surface metal raceways and fittings, multi-outlet systems, fluorescent and slimline lighting equipment, and non-metallic flexible conduit, with detailed installation instructions. Catalog lists fittings, covers fastening methods, wiring for spotlights, graphical electrical symbols, and provides illustrations of various types of installations. The Wiremold Co.

122 Insulated Power Cables — Described in Bulletin AVA-10 are asbestos varnished cambric insulated power cables for use in high temperature locations.

Applications of this group of cables is discussed, and complete specifications and technical information given on three principal types. Triangle Conduit & Cable Co., Inc.

123 Portable Electrical Cable — Detailed information on portable electrical cable for a variety of industrial applications is presented in this condensed catalog. Basic construction is detailed and tables of essential data and specifications included. Western Insulated Wire Co.

124 For Wiring Installation — Sectionalized Catalog 158 covers company's line of wiring installation equipment. Section 158-A covers conventional wireways, fittings and lay-in ducts, as well as flanged hinged-latched-cover wireways, fittings and wiring troughs. Section 158-B is devoted to cutout and pull boxes, telephone and current transformer cabinets, control panel enclosures, terminal and pull boxes and oil-tight pushbutton enclosures; and Section 158-C lists outlet boxes and switch boxes. Each section contains dimensional specifications and comparative data, as well as code requirements. Keystone Mfg. Co.

125 Crane Controls — Two bulletins on a-c and d-c crane control have recently been published. Both bulletins describe master switches, disconnects, limit switches, frequency relays, brakes, and other components of the various crane control systems. Bulletin 6100 is on d-c crane control and Bulletin 6400 is on a-c crane control. Electric Controller and Mfg. Co., Div. Square D Co.

126 Power Package — Bulletin AR-101/58 describes operation of company's combination power package of silicon charger and long-life lead-calcium plate batteries. Explains performance of both charger and battery, and includes curves and diagrams illustrating discharge and charging characteristics, as well as other information. C & D Batteries, Inc.

127 Lighting Maintenance Tips — Principles and advantages of good lighting practice are presented in this 48-pp lighting maintenance manual. Much useful information has been added to this revised edition, including a guide to trouble shooting fluorescent installations, a section on planning the group replacement of lamps, and a section on planning a program for cleaning lamps and fixtures. Champion Lamp Works.

AIR CONDITIONING AND VENTILATING

128 Putting Air To Work — Booklet D-5199, 32 pp, covers treatment and distribution of air and products available for the job. The well-illustrated booklet has sections on air handling, air conditioning, air heating, and electronic air cleaning. Also included are descriptions of applications in these categories as well as descriptions of the applicable products, together with pertinent application data. Sturtevant Div., Westinghouse Electric Corp.

129 Dual-Duct Systems — Design, layout and installation data for high velocity dual-duct systems are featured in this 24-pp reference bulletin. Covers construction details for rectangular high pressure ducts, design procedures, as well as basic schemes of air distributing systems, dual duct air handling apparatus, budget costs for such systems, automatic control, winter and intermediate season operation and dual duct construction. Buensod-Stacey, Inc.

130 Air Conditioning Units — Bulletin 786 contains 54 pp of information and selection data on air conditioners, including capacities, standard arrangements, dimensions, and suggested specifications. Steps in selection of basic unit and components are outlined, and how various components may be selected to build a unit meeting job requirements is discussed. First pages are devoted to choosing physical size based on air capacity and face velocity requirements, while succeeding pages cover heating and cooling requirements, temperature control, humidity requirements and filtering and air mixture demands. American Air Filter Co., Inc.

VALVES, TRAPS, PIPING AND ACCESSORIES

132 Control Valves — Design and operation features of air and hydraulic control valves are described in 12-pp Bulletin 571. Includes general information on the valves, as well as detailed operation data, photos and cutaway views illustrating features. C. B. Hunt & Son, Inc.

133 Water Control Valves — Nine automatic water control valves and their uses are described in 8-pp Bulletin G-5A. Covered are cushioned check valves, water level control valves, sensitive pressurized regulators and one-man control valves. Photos of typical installations included. Golden-Anderson Valve Specialty Co.

134 Butterfly Valves — Features, advantages, dimensions, operators, and technical characteristics of rubber seated butterfly valves for both tight-closing and throttling applications are described in Bulletin 650-R2. Application photos, cutaway views and a dimensional chart are included. Sizing nomograph permits quick selection of valve for a given application. Builders-Providence, Inc., Div. B-I-F Industries, Inc.

135 Automatic Valves — Condensed Catalog P & H-58, 12 pp, features company's line of automatic valves for a variety of industrial applications. Convenient specification tables give valve type, pipe size, rating, and shipping weights. A. W. Cash Valve Mfg. Corp.

136 Forged Steel Traps — Catalog 200 describes company's forged steel steam traps for steam tracing and instrumentation service. Operation and installation information is included, as well as physical data and price list, and capacities. Velan Steam Specialties Inc.

137 Simplified Filtration Piping — Eight-pp Form 158 describes the uses of company's couplings on filtration plant piping in modern water treatment plants. Contains photos illustrating applications on discharge lines, pump and valve connections, raw water lines, chemical lines, and others. Table of sizes and specifications included. Dresser Mfg. Div., Dresser Industries, Inc.

138 Guide to Couplings — This 26-pp general catalog describes company's quick-connect, quick-disconnect couplings, including a coupling for high pressure applications, for impact in air lines, for low pressure applications, for vacuum and very low pressures, and for hard to handle fluids. Illustrates construction details through cutaway drawings, and includes graphs and charts of flow and pressure drop data. Snap-Tite, Inc.

139 For Piping Flexibility — Eight-pp Bulletin 28A illustrates numerous applications of swing joints, flexible ball joints, and flexible strut joints, especially for petrochemical plants, oil refineries, and the petroleum industry. Photos and diagrams illustrate solutions to problems regarding the handling of thermal expansion in permanent piping installations, and handling of hot asphalt or loading lines. Barco Mfg. Co.

140 Expansion Joints — Information for rating expansion joints subjected to axial or lateral movement, angular rotation or combinations of these movements, together with formulae and tables for calculating forces and/or bending movements developed in the connected piping or equipment are featured in 80-pp Catalog EJC-581. Also included are tables of dimensions and weights for expansion joints from 3- to 72-in. diam, as well as other data required to select, order and install the joints. Badger Mfg. Co.

INSTRUMENTS AND CONTROLS

141 Variable-Area Flowmeter — Fifteen-page Catalog 10A9010 gives basic engineering data on company's variable-area flowmeter, including tables, graphs and equations for application, sizing and flow rate calibration prediction of low flow rate rotameters. Float characteristic curves are included. Fischer & Porter Co.

142 Bi-Color Gage — Bulletin 2044 describes advantages of the Multi-Port bi-color gage developed to eliminate common gage troubles encountered in low and medium pressure ranges. Design features are illustrated and described and installation methods detailed. Diamond Power Specialty Corp.

143 For Speed Measurement — A wide selection of speed measuring instruments for applications in all industries is illustrated and described in 20-pp Bulletin 35. Operation details are included, as well as complete specifications, and photos and diagrams. James G. Biddle Co.

144 Bin Level Indicators — This 20-pp catalog features three products for bulk material, level indication and control. Includes illustrations, outline dimensions, general specifications, and applications for the Bin-Dicator, diaphragm type bin level indicator; Roto-Bin-Dicator, rotating paddle type bin level indicator; and Bin-Flo Aerator, to promote flow of dry, finely ground materials. The Bin-Dicator Co.

Postage-free cards for ordering catalogs are on page 121. You may also use the cards to order literature mentioned in the ads.

145 Pump Governor — Bulletin 1047 describes a governor designed especially for steam driven reciprocating pumps or centrifugal pumps driven by small steam turbines. A cross-section view shows construction features of the balanced-flow valve and operating diaphragm. Also included are suggested piping diagrams and a table of specifications. Copes-Vulcan Div., Blaw-Knox Co.

Hall Industrial Water Report

VOLUME 6 SEPTEMBER 1958 NUMBER 5

Drought Ends in Dry Southwest

Long-overdue rains have brought desperately needed water to the southwest mining industry. With water supply less critical, mine operators can breathe easier. But the abundance of water does not mean that they, or operators of any industry using water, can be less vigilant in treating the water for service, cooling, boilers, process or waste.

Hall Engineers are particularly helpful when water is at its worst. However, their services are just as important when more and better water is available. Even the best water usually requires treatment to avoid problems such as turbidity, scale, corrosion, foaming or biological slimes. Water can always cause trouble.

Softener Bypassed

The feedwater for a waste-heat boiler at a southwestern smelter is zeolite softened and then dealkalized by ion exchange. Tests showed the treated water to be normally soft and free of brining solution.

These apparently good conditions were belied by excessive phosphate consumption and by the presence of a lot of sludge in the boiler. Further testing revealed that the dealkalized water was almost one-half as hard as the raw water.

Together with the operating men, Hall Engineer J. F. Nelson made a thorough search for the source of the hardness. The "leak" was found to be an open valve in a bypass pipe around the zeolite softener. The valve had been opened when a temporary demand for water had exceeded the softener capacity and had not been closed.

With the valve closed, phosphate consumption dropped to its normal level. Nelson recommended installation of another zeolite softener so there will never be any need to open the valve in the bypass line.

Tailoring Water

A Pennsylvania manufacturer of mining tools operates electric induction furnaces cooled with well water high in temporary hardness and iron. The water also contains a lot of hydrogen sulfide—enough so that employees carried drinking water from their homes to avoid the bad taste and odor of the plant water.

Use of the poor quality water resulted in accumulation of deposits in the furnace cooling coils. The furnaces had to be shut down for cleaning about every second week.

When Hall Engineer D. C. Altenburger reviewed the situation with plant personnel he recommended the addition of Calgon® to the water at each well. Also chlorination of the mixed water to destroy the hydrogen sulfide.

Now, after several months, no cleaning of furnace coils has been necessary. The water no longer has an odor and employees can drink it at the fountains.

Boiler Damage Prevented

After trying unsuccessfully for three days to reestablish satisfactory boiler water conditions following a sudden large increase in dissolved solids and disappearance of phosphate and alkalinity, a Michigan salt refinery called on Hall Engineer C. H. Turner for help. On arriving at the plant he found that feedwater composition was normal but boiler water conditions were intolerable.

Turner's first acts were to open wide the continuous blowdown, arrange for hourly opening of main blowoff valves and start feeding large quantities of phosphate and caustic soda. Seven hours later, conditions were nearly back to normal.

The next move was to determine the source of the trouble. This wasn't easy because no one had noted anything out of the ordinary except the change in boiler water conditions. About 3:30 a.m., when almost everyone had gone home, Turner talked with the janitor, who knew nothing about the trouble but did furnish the vital clue. He recalled that the turbo-generator had been out of service for a short period a few days before. Turner reasoned from this that steam pressure on the salt pans had dropped low enough to permit gross contamination of condensate by inleakage of salt brine high in calcium chloride.

The steps taken prevented damage to the boiler so the only cost to the plant was the extra chemicals required. Profiting by this cheap warning, the plant has made changes to prevent a recurrence of the difficulty. Leaks in the salt pans have been repaired and devices have been installed to detect any further contamination of condensate.

Nitrogen Capping

Some standby boilers must be kept filled with water, ready for service. Chemical treatment protects the surfaces contacted by water. However, protecting superheaters and reheaters from corrosion is more difficult. The problem is being solved in some plants by maintaining nitrogen under slight pressure in all vapor spaces of idle boilers, superheaters and reheaters.

Nitrogen capping is also being used for standby protection of heaters, turbines, piping, pumps, etc. Surge tanks, receiver tanks and similar equipment can even be protected during operation. The essential features are: (1) an uninterrupted supply of nitrogen low in oxygen content; (2) nitrogen pressure held higher than atmospheric pressure; (3) routine checks to make sure there are no lapses in this control.

Industrial Water Problems Require Special Handling

There are no "stock answers" to industrial water problems. For information on how the Hall System can help you solve *your* water problems, write, wire or call address below.

Water is your industry's most important raw material. Use it wisely.

HALL LABORATORIES
DIVISION OF HAGAN CHEMICALS & CONTROLS, INC.
HAGAN BUILDING, PITTSBURGH 30, PENNSYLVANIA
DIVISIONS: CALGON COMPANY, HALL LABORATORIES
IN CANADA: HAGAN CORPORATION (CANADA) LIMITED, TORONTO

Hall Laboratories—Consultants on Procurement, Treatment, Use and Disposal of Industrial Water

For more data circle 516 on Post Card

ROTOJET®

Cleans TUBES and PIPES

ANY SIZE

from ½" to 12" I.D.

STRAIGHT or CURVED

Roto engineers are constantly designing new equipment to meet new conditions and applications for its tube cleaners. If you have a pipe or tube cleaning problem, we will be pleased to place our long specialized experience at your disposal. Write, wire or

Phone HUmboldt 3-0570

Illustrated are a few of the many types and sizes of Rotojet Tube Cleaners driven by air, steam or water. We analyze each application before recommending equipment that best meets the requirement.

ELLIOTT COMPANY – ROTO PLANT

Tube Cleaner Specialists Since 1910

147 Sussex Avenue, Newark, N. J.

For more data circle 517 on Post Card

146 Liquid Level Controls — This 16-pp catalog describes a system of liquid level control which operates without floats and with no moving parts in the liquid. Liquid level relays, electrodes, signals, alarms, and alternators are covered, and charts and diagrams of typical applications included. B/W Controller Corp.

147 Miniature Thermocouples — Four basic designs of miniature thermocouples — gasket, bayonet, protected and shielded — are described and illustrated in this 28-pp catalog. Ordering and installation instructions are provided, as well as information on uses and advantages of each type, calibrations and temperature ranges, details of construction, adapters and mounting accessories, thermocouple leads, and temperature conversion tables. Thermo Electric Co., Inc.

OTHER EQUIPMENT

148 Water Tube Package — Featured in this 20-pp bulletin are a package two-drum water walled steam generator for oil-gas-coal and a two-drum factory built or field erected steam generator for any firing method. Design and construction features are detailed and engineering data tabulated. Erie City Iron Works.

149 Stainless Steel Hose — Engineering Data and Specification Folder SSDS-562 describes advantages of stainless steel flexible hose in handling heat, pressure and corrosive media. Gives engineering information and tabular data on pressure capabilities, flexibility, suggested usage, formulae for determining best lengths, etc. Allied Metal Hose Co.

150 Hydraulic Fittings — Catalog 556, 28 pp, is devoted to company's line of hydraulic tube fittings. Catalog is divided into three sections — covering self-flaring fittings, no-flare fittings and flare-type fittings. Each section contains information on the design and installation of the type covered plus detailed dimensional and engineering specifications. Flodar Corp.

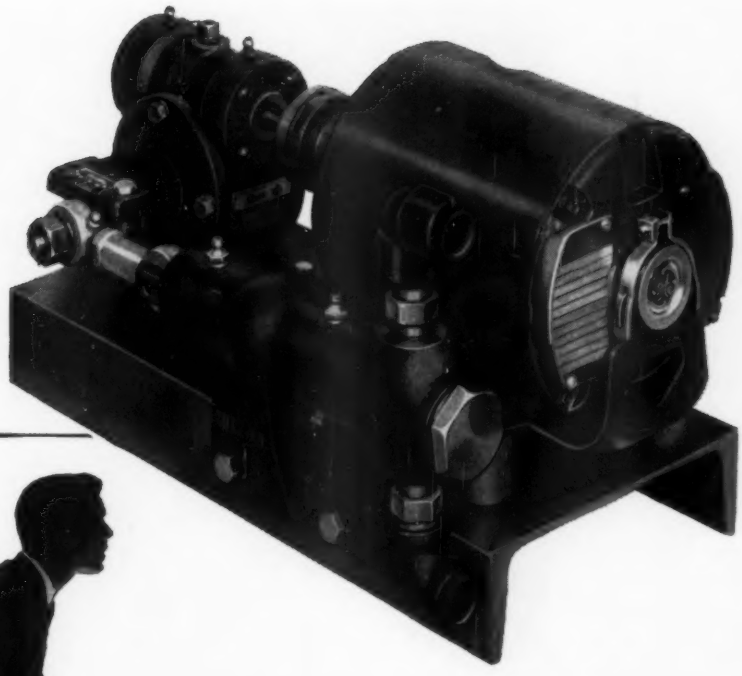
151 V-Type Engines — Featured in 18-pp Bulletin 262 is a line of four-cycle V-type engines with improved diesel engine performance. Design and construction features are explained, and engine components shown on cross section drawings. Photos of typical applications are included, and specifications. Nordberg Mfg. Co.

152 Plastic Steel — Twelve-page Catalog NI-103 describes plastic steel and other products for the metal working, plastics, and other industries. Besides a complete coverage of the chemical and physical properties of these products, catalog also contains illustrated case history type applications. Devcon Corp.

153 Oil Conditioner — Facts about an oil conditioning system which dehydrates, filters, purifies and deaerates oils are detailed in this 12-pp bulletin, Schematic flow diagrams, performance curves and specifications included. Bowser, Inc.

154 Conveyor Belt Carrier — Bulletin 355, 20 pp, features comprehensive technical data, specifications and illustrations on conveyor belt carriers for conveying bulk materials. Dimensional data and diagrams are included. Stephens-Adamson Mfg. Co.

157 Rubber Products — Applications of rubber products in construction work are detailed in this 8-pp bulletin. Covering various types of hose and con-



Look again

At the Milton Roy H20® Controlled Volume Pump

Here's low-cost protection for your boilers . . . Milton Roy H20 controlled volume pumps have capacities ranging from 0.12 to 56 gph, for pressures up to 1100 psi. Both simplex and duplex models are available—for immediate delivery from stock—with stainless steel or cast iron liquid ends.

H20 pumps will give you accurate metering—efficiently and economically—of boiler-water treatment chemicals and other mildly corrosive and non-corrosive liquids. Depend on these pumps for long service life with a minimum of maintenance. And Milton Roy H20 pumps are available in complete packaged systems for boiler feed-water treatment . . . consisting of a steel tank, H20 pump, relief valve and suction piping.

Take a second look at these quality pumps . . . and always look to Milton Roy for assistance in the solution of your most difficult controlled volume pumping problems. Write for detailed information—Bulletin 557—Milton Roy Company, 1300 East Mermaid Lane, Philadelphia 18, Pa. Engineering representatives throughout the world.

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You want pump packings which will hold up under temperatures to 600°F...

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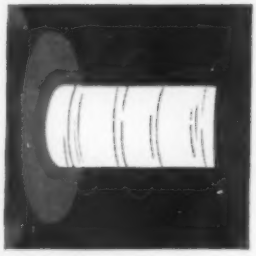
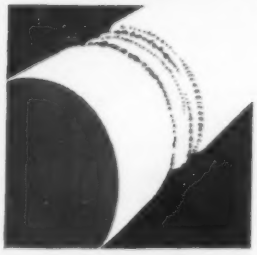


...packings whose lubricants will not go up in smoke when the heat and speed are on...

ADD UP TO TROUBLE UNLESS . . .



...because improper packing materials can cause costly damage to parts, interfering with your production.

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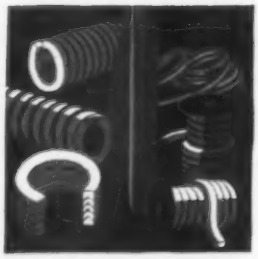

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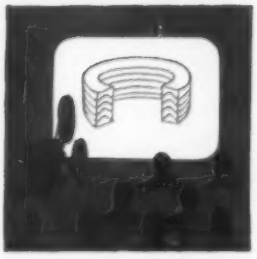

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veyor belting, bulletin features information on application, construction, lengths and sizes, and gives working pressures, weights. Hamilton Rubber Mfg. Corp.

158 Cycloidal Blowers — Bulletin VP-158 covers cycloidal blowers for vacuum service. Presents detailed design and construction data, technical data on capacities and ratings, and a cutaway view showing design features. Roots-Connersville Blower, Div. Dresser Industries, Inc.

160 Pneumatic Products Data — Twenty-pp Catalog 616 features air line filters, regulators, and lubricators. Includes complete engineering and operational data, performance characteristics, "quick sizing" charts. Watts Regulator Co.

. . . *Outstanding Among This Month's Catalogs*

162 Tips on Pump Motors — This 26-pp liberally illustrated and charted instruction manual covers both Verticlosed oil-lubricated and grease-lubricated pump motors. Installation instructions are given on mounting, oil-fill, electrical connection, mechanical connection, and use of upthrust protection. Operating instructions cover ventilation, first-time starting and stopping check-list, shutdown protection, and lubrication directions. Tables of recommended oils and greases included. U. S. Electrical Motors Inc.

163 Safety Codes — The "F.E.M.A. Handbook of Safety Codes" outlines the various procedures for maintaining, protecting, recharging, and inspecting fire extinguishing equipment commonly used in power plants. Containing 42 pp, the brochure presents both mandatory and recommended procedures to be followed to assure efficient service from portable fire extinguishers, carbon dioxide systems, standpipe and inside hose systems. Fire Equipment Manufacturers' Association, Inc.

164 Aluminum Electrical Conductors — With publication of 88-pp "Aluminum Electrical Conductors — General Engineering Data," (Section DA2A) power engineers may consult a complete listing of approximately 4,000 immediately available sag and tension charts encompassing virtually every type of covered and bare aluminum conductor. Included is a glossary of aluminum conductors, listed alphabetically. Aluminum Co. of America.

165 Data on Insulation — Tables and reference data commonly used by field workers in industrial insulation work have been compiled in this 22-pp handbook. Contents include definitions of terms, bare surface heat losses, effect of wind on insulated and bare surfaces, precalculated surface areas, complementary pipe insulation sizes, various conversion tables, and other tables, charts and calculations. The Aber Co.

166 Refractory Brick — Entitled "Refractory Brick and Other Shapes For Industry," this 24-pp bulletin has been designed as an aid in selection of proper refractory products for high temperature applications. Includes technical data, tables, graphs, conversion charts. Norton Co.

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Low cost refractory stack outlasts steel

Low cost — The Van-Packer Industrial Stack is made of prefabricated sections for economy and easy installation. It costs no more than a steel stack, yet lasts substantially longer. Costs only a third as much as a brick stack.

Refractory construction — Van-Packer Stack sections are centrifugally-cast of refractory material that will not corrode. Three-foot long sections come in 7 diameters from 10-inch ID to 30-inch ID to meet your requirements.

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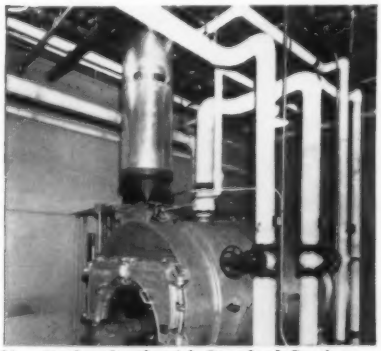

Van-Packer Stack with Standard Sections handles boilers and furnaces efficiently. Can be superimposed or floor supported.

Installing this stack is quick and easy. Three-foot sections are simply cemented atop one another with acidproof cement.

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Sweet's

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makes all three

All three Research-Cottrell dust collectors are engineered for specific fly ash applications. Research's experience as the world's largest manufacturer of precipitators is well known. Over 600 straight and combination fly ash precipitators have been installed throughout the United States and Canada. • Research's Cyclo-trell, available since 1956, has already set new standards of efficiency for mechanical dust collectors. • For more information on Research-Cottrell's line of engineered dust collecting equipment, write for Bulletin PC.

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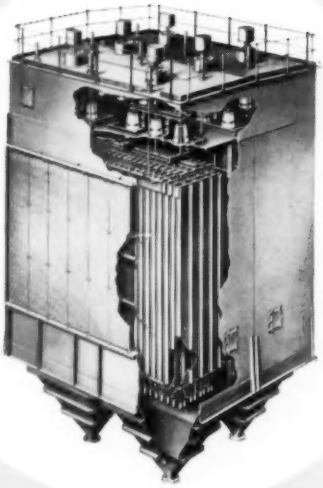

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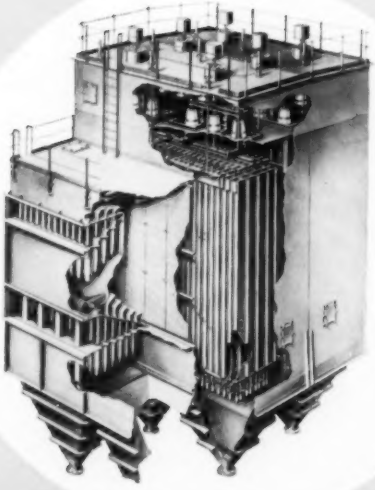

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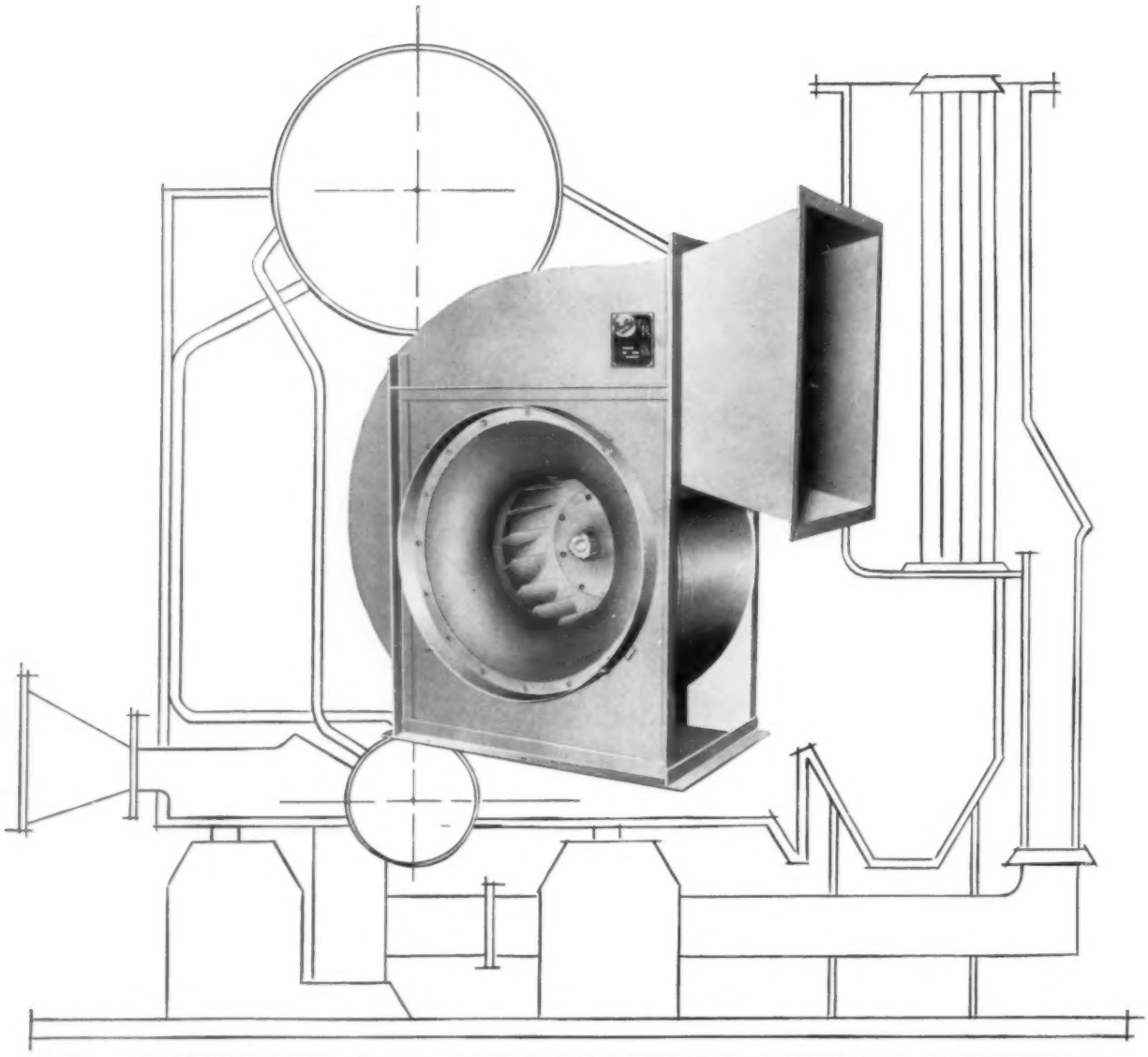

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Combining sharply rising pressure and horsepower characteristics with high static efficiency and resistance to abrasive effects, the "CR" is an ideal fan for stoker-fired or pulverized coal boilers. It is also proving an excellent choice for handling air with dust loadings in a wide range of industrial jobs. Too, these same high-pressure, high-capacity characteristics may mean a smaller fan for many direct-connected applications — a saving in first cost.

Write for Bulletin FD 205 and see the dependable, stable performance built into this husky radial wheel fan for constant volume or inlet-dampered operation. It's one of a *series* of specialized "Buffalo" Draft Fans — including airfoil and backward curve designs with a wide choice of wheels — to give you the best service your operation requires.

NOTE: *Every "Buffalo" Fan has the exclusive "Q" Factor—the built-in Quality which provides trouble-free satisfaction and long life.*

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VENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT EXHAUSTING FORCED DRAFT COOLING HEATING PRESSURE BLOWING

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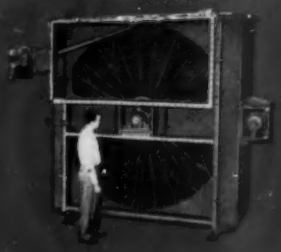
Here's what you can do about the high cost of fuel.



Get the same heat from cheaper fuel with a

LJUNGSTROM® PACKAGE AIR PREHEATER

You can get standard operating temperatures from the cheaper fuels if combustion temperature is high enough. Peat, bagasse or even wood can be used successfully. The Ljungstrom Air Preheater can increase combustion temperature by as much as 300° by recovering heat from the exhaust gas. This reclaimed heat would otherwise go up the stack. All it costs is the price of the preheater—and the Ljungstrom can save enough on fuel to pay for itself in approximately two years.

You can be sure of maximum heat recovery because the Ljungstrom's exclusive rotary heat transfer element picks up the heat from the exhaust and puts it back into the combustion air without passing it through partitions or tube walls. Package design gives you all the advantages and economies of the Ljungstrom in a compact, preassembled unit. The Package Ljungstrom is available in vertical or horizontal models that are readily adaptable to any plant arrangement.

For further information, write today for the free 14-page Package Ljungstrom manual.

THE AIR PREHEATER CORPORATION

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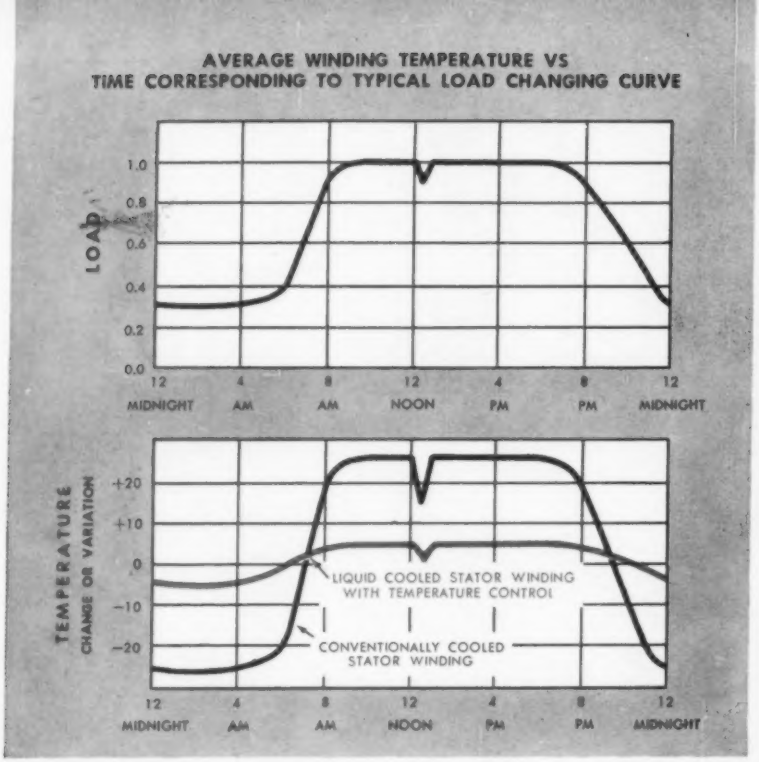
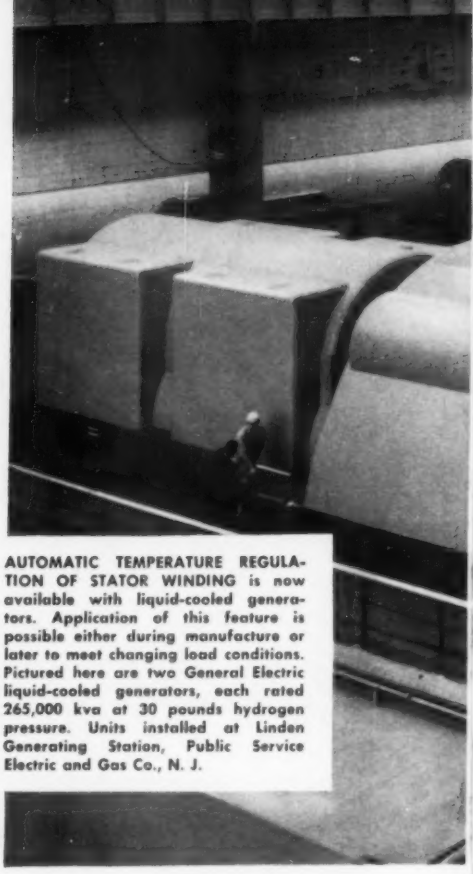


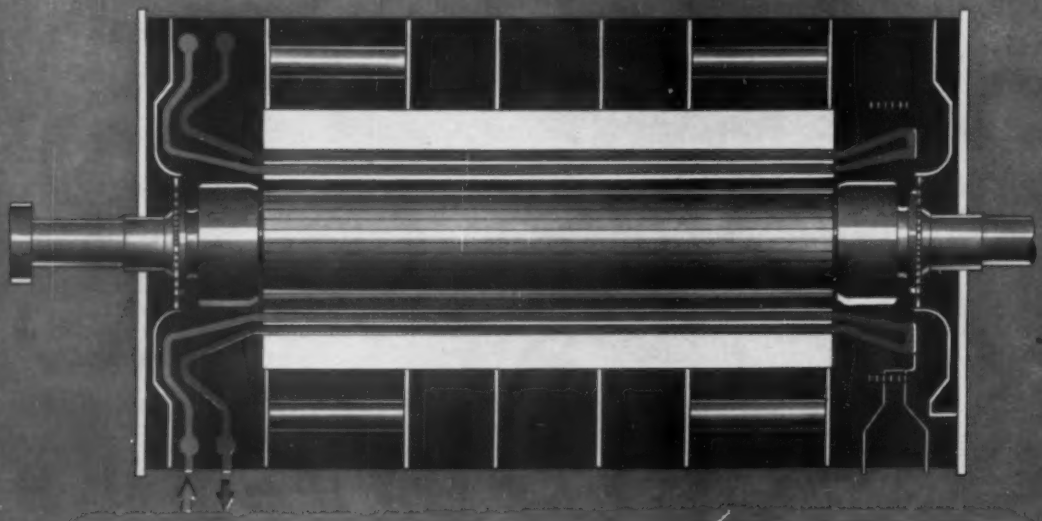
MINIMUM VARIATION OF STATOR TEMPERATURE is possible with liquid cooling, in spite of changes in generator load. Since the liquid coolant is in direct contact with the hollow conductors, the temperature difference between them is only a few degrees. Therefore, by thermostatic control of the coolant, average copper temperature can be kept essentially constant, thus minimizing thermal stress cycling on the insulation.



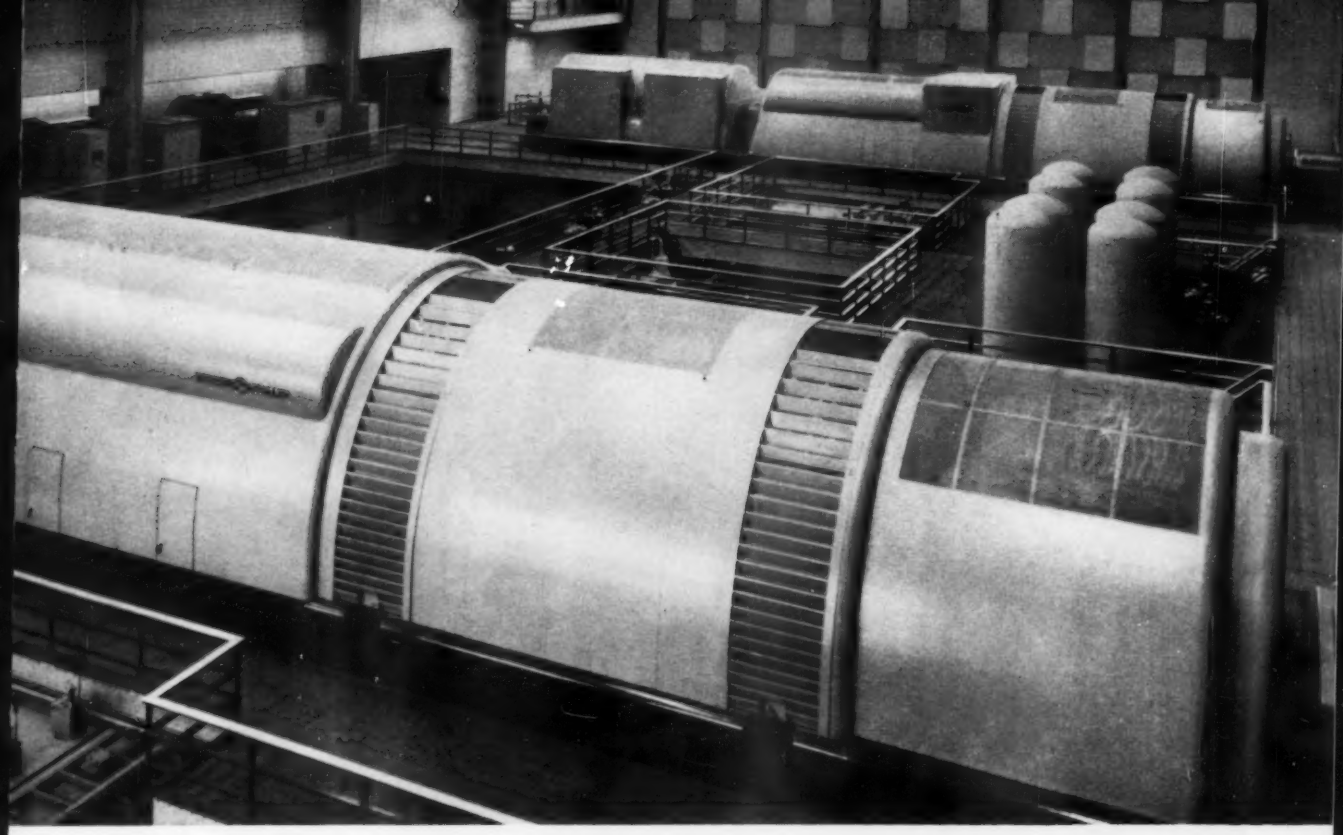
AUTOMATIC TEMPERATURE REGULATION OF STATOR WINDING is now available with liquid-cooled generators. Application of this feature is possible either during manufacture or later to meet changing load conditions. Pictured here are two General Electric liquid-cooled generators, each rated 265,000 kva at 30 pounds hydrogen pressure. Units installed at Linden Generating Station, Public Service Electric and Gas Co., N. J.

WITH HIGHER RATINGS NOW POSSIBLE FOR GENERAL ELECTRIC GENERATORS...

Liquid cooling system permits control of



SIMPLICITY OF THE LIQUID FLOW CIRCUIT adds to reliability. As shown here, highest copper temperature is near the end of the bar, making possible automatic regulation of stator temperature by regulating the flow and temperature of the inlet coolant. Automatic throwover features in the pumping system and other protective devices all contribute to the dependability and continuity of operation of liquid-cooled generators.



stator winding temperature independent of load

REDUCED THERMAL STRESSES HELP EXTEND INSULATION LIFE

In addition to the greater capacity available with liquid cooling, generators may be operated in essentially the same manner established by the successful operation of more conventional machines.

The liquid-cooling system permits generator output to be increased or decreased with minimum variation of stator winding temperature. Since the cooling liquid at the outlet reflects within a few degrees the actual maximum copper temperature of the bars, the inlet coolant temperature may be regulated—automatically—to maintain copper temperature almost constant, regardless of load.

Longer insulation life is the result, since with uniform stator temperature there is much less expansion and contraction of the stator bars. Automatic regulation of stator temperature can be applied most effectively to liquid-cooled machines either during manufacture or later, if desired. This is just one of the many important features of General Electric liquid-cooled generator stators. Other outstanding features are:

Increased Generator Output—*Hollow strand stator bar construction can remove up to 16 times more heat than conventional cooling arrangements, permitting higher generator ratings.*

Maximum Efficiency—*Little power is required to circulate the coolant; also a larger cross-section of copper is provided in the winding.*

Design Simplicity—*Dielectric system maintains the simplicity and dependability of conventionally-cooled machines.*

Dependable Operation—*Many unique features are incorporated into the design of the closed coolant system to provide a permanently tight liquid circuit.*

Shorter Maintenance Inspections—*Simple, single-stage, low-pressure hydrogen circulating fans facilitate disassembly and inspection.*

For more information on liquid cooling, contact your nearest Apparatus Sales Office or write for bulletin GER-1231, Large Steam Turbine-Generator Department, General Electric Company, Schenectady 5, N. Y.

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GENERAL ELECTRIC

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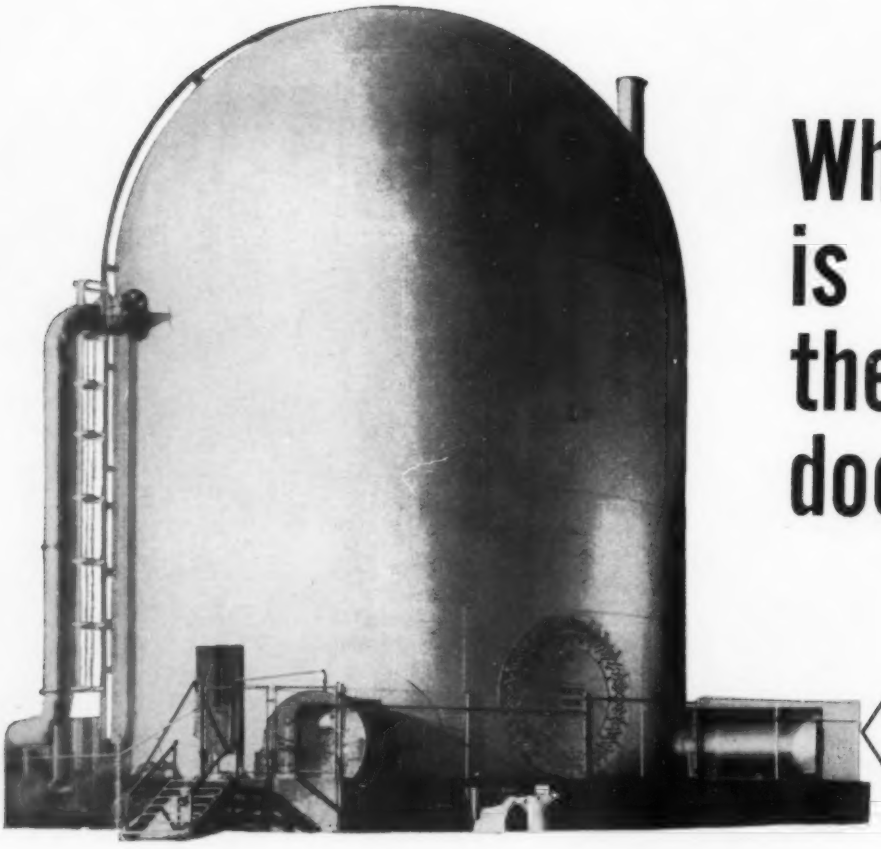

Where is the door?

These two tubular entrances are the Pratt Air Locks in the Vallecitos Boiling Water Reactor at the General Electric Vallecitos Atomic Laboratory at Pleasanton, California.

The Henry Pratt Personnel Air Lock

provides easy passage in and out of containment vessels in full compliance with the AEC code for reactor construction.

While the Air Locks are designed and built specifically for each atomic power plant, they all include some very desirable Pratt developments.

An interlocking feature that keeps one door shut while the other is open is typical of the many simple operating principles that add up to a high safety factor. Any arrangements of automatic and manual controls can be incorporated.

The locks can be built to withstand any practical pressure with compression or pneumatic door seals . . . size is no problem—locks are now being built that will accommodate trucks.

Air Locks already installed . . . Two locks in the Boiling Water Reactor of General Electric's Vallecitos Atomic Laboratory, Pleasanton, California . . . Two locks in the M.I.T. Research Reactor.

Air Locks now being built. . . Three locks for the C.N.R.N. Reactor, Ispra, Italy . . . One lock for the Enrico Fermi Atomic Power Plant of the Detroit Edison Co., Laguna Beach, Michigan . . . Two locks for the 30 MW Test Reactor at the General Electric Vallecitos Atomic Laboratory, Pleasanton, California.

Manufacturers of
Personnel Air Locks
Rubber Seat Butterfly Valves
Turbine-Condenser Expansion Joints
Paper Mill and Converting Equipment
Specialized Steel Fabrication

HENRY PRATT

One of the two Pratt Air Locks now in use at the M.I.T. Research Reactor.

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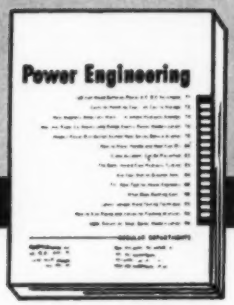


ATOMICS

308 EAST JAMES STREET
BARRINGTON, ILLINOIS

A POWER ENGINEERING FEATURE FOR UTILITY & MAJOR INDUSTRIAL EXECUTIVES

A. W. Kramer, Editor

A Periodic Report on Atomic Energy Development Throughout the World
Published by Technical Publishing Co.

September 1958

Costly necessity. Perhaps the least exciting part of a nuclear reactor is the shielding provided to limit the radiation to a safe value. Usually this takes the form of heavy concrete walls or, as in the case of the swimming pool reactor, a pool of water. Yet, the shielding is of prime importance, since it would be virtually impossible without it to operate even the lowest powered research reactors.

The need for shielding, of course, had been apparent ever since the harmful effects of X-rays and radiation from naturally radioactive substances became known in the early years of this century.

With the invention of the nuclear reactor, however, a new phase was initiated in the development of shielding. Overnight, the intensities of radioactive sources increased enormously and shields for these intense sources have become quite formidable. The elaborate and ingenious techniques devised for working within the limitations of such massive shields have developed into a new, and often picturesque technology. In most reactor installations the shield is much larger in volume and weight than the reactor core, and even with stationary reactors, the cost of constructing the shield forms a large fraction of the over-all cost. With mobile reactor applications, where there are obvious restrictions on weight and bulk, shielding considerations can play a determining role. Shielding needs alone, for example, preclude any possibility of a nuclear-powered automobile.

Types of shields. The most obvious reason for shielding a reactor is that the radiations emitted are injurious to man. Therefore, we speak of the biological shield for a reactor. It is frequently necessary to have a biological shield even for locations which are not usually occupied. For example, in the absence of shielding, neutrons can activate objects which thereby become radioactive and are themselves turned into sources of harmful radiation for anyone coming near them at a subsequent time.

Protection of personnel is, however, not the only reason for shielding. The gamma and neutron radiation from a reactor carries almost 10 per cent of the reactor power. Considerable heat may be generated in an object through which the radiation passes. Where this is undesirable, shielding may be used to reduce the energy flux of the emitted radiation to acceptable levels. The shielding for this purpose is often called the thermal shield.

Nuclear radiation also may interfere directly with the proper functioning of various types of apparatus. For example, photographic film is often

rendered useless at radiation levels which are not injurious to man. At much more intense levels there may be difficulty in operating electronic equipment because of ionization of the surrounding air. From discussions of fission weapons in the open literature it is also clear that it may not be desirable for these weapons to be operated in areas of high neutron flux. By and large, however, shielding for the protection of equipment plays only a small role in the over-all shielding problem for the special requirements involved are usually easily satisfied.

Types of Nuclear Radiation. There are present in a nuclear reactor and its surrounding shield almost all known types of nuclear radiation with the exception of mesons (other than from cosmic rays). Neutrons and gamma rays are emitted both in the primary fission process and in some of the secondary processes. The fission fragments themselves, being heavily charged ions, can cause damage, and must be included as part of the nuclear radiation field. Generally, they are also radioactive, and emit, among other particles, beta rays (electrons and positrons) and neutrinos. In addition, beta rays can result from various secondary processes caused by gamma rays and neutrons. Finally, as a result of nuclear reactions in the reactor core or shield, there will appear heavy charged particles such as protons, deuterons, alpha particles, etc. For convenience, this complex assortment of nuclear particles may be divided into two classes, charged and neutral, as listed in the following tabulation:

Nuclear Radiation Involved in Reactor Shielding

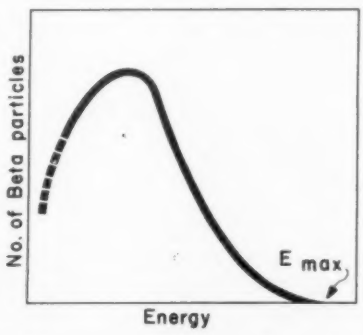
Charged	Neutral
Fission fragments	Neutrinos
α particles	Neutrons
Tritons	γ rays
Deuterons	
Protons	
β rays (+ and −)	

Not all of these radiations are of equal importance for shielding. The charged particles, for example, by virtue of their electrical charge, interact strongly with the atomic electrons of the matter they pass through, and very quickly lose their energy. They can thus be stopped in relatively thin layers of material. For particle speeds much less than that of light, the range of given energy roughly decreases inversely as the mass times the square of the charge. The fission fragments, although carrying most of the energy released in fission, are thus usually stopped well within the fuel elements themselves. Other charged heavy particles, protons, alpha particles, etc, have longer ranges but still very much less than the thickness of structures normally found in the reactor core. An alpha particle of 10 Mev energy is stopped in a material such as air or plastics in the order of 10^{-2}gm/cm^3, which even in a gas like air corresponds to no more than a few cm. Under the same conditions the range of the proton is about ten times as large; still negligibly small.

As would be expected from its smaller mass, the range of an electron of a given energy is much larger than for the heavy particles. An electron of about 5-Mev energy has a range in air of 22 meters, but only 2.6 cm in water, or 0.33 cm in lead. Even with these ranges it will be obvious that it is usually relatively cheap -- in weight, volume, and cost -- to stop electrons with the energies normally encountered. One important reservation must be made, however. Electrons of energies of several Mev or higher, when passing through materials of high atomic number, like lead, lose energy by radiating gamma rays -- a process known as bremsstrahlung. These gamma rays may be much harder to stop than their parent electrons, and the possibility of their presence must be carefully considered in shield design.

The Neutrino. Now we come to the neutrino. The neutrino is a strange particle, perhaps only a concept, though in recent years we have experimental evidence of its existence, which has neither charge, mass, nor magnetic moment. Therefore it cannot interact with electric, magnetic, or gravitational fields. Its only interaction with matter is through purely nuclear forces, which are here so weak that on the average a neutrino could penetrate through a hundred million stars of the dimensions of the sun before making a single collision.

The concept of this elusive and almost impossible particle arises that in the emission of beta particles we find a continuous distribution of energies. This is not true for alpha particles. All alpha particles from a given source have essentially the same energy, or they fall into two or three groups of definite energy; Beta particles, on the other hand, have a continuous distribution of energies; namely, a continuous energy spectrum up to a fairly definite maximum for each particular source, as indicated by the curve shown here. This maximum energy is believed to be equal to the total energy of the radioactive transition, and it has been suggested that the difference between the maximum and the actual energy of the beta particle is carried off by an electrically neutral particle of negligible mass, called a neutrino.



Energy spectrum of beta particles

One cannot hope to attenuate neutrino fluxes by shielding, but correspondingly, with no mechanism for interaction with matter, neutrinos cannot cause damage to biological material. Despite the fact, therefore, that neutrinos carry away some 5 per cent of the power of a reactor, they do not pose a shielding problem. It is impossible to shield against nothing, and the neutrino comes about as close to nothing as anything one can think of.

Neutrons and Gammas. In contrast to the radiations previously discussed, neutrons and gamma rays provide the main burden of the shielding problem. They interact strongly with matter, and therefore with biological material. Gamma rays, of course, are X-rays of an extremely penetrating nature. However, these radiations do not generally interact so strongly that they can be satisfactorily attenuated with small amounts of material. Also, there is a fundamental difference in the manner in which neutrons and gamma rays are attenuated in comparison with charged particles. An electron or heavier charged particle loses energy mainly by a multitude of collisions in which it just brushes by an atom without changing direction. This process continues essentially unchanged until the particle has lost all its energy and is neutralized. The particle thus effectively disappears in a distance, called the range, which depends only on the type of particle, initial energy and medium, with only small statistical fluctuations in the magnitude of the range from one particle to the next. An absorber slightly smaller than the range transmits almost all of the particles; an absorber somewhat larger than the range permits virtually none of them to emerge.

In contrast, a neutron or gamma ray may be completely absorbed in the first collision it makes, or may suffer large changes in both energy and direction. There is an average distance between collisions -- the mean-free-path length -- but the probability of first collision is distributed exponentially along the path of the particle. This exponential behavior is dominant in determining the total penetration, and thus there is no sharply defined distance for neutrons and gamma rays (comparable to the range of charged particles) beyond which they are completely eliminated. The mean-free-path length is not to be compared with the range, but is more analogous to the microscopic distance between the individual brushes of charged particles with atoms. For this reason, the attenuation of intense beams of neutrons and gamma rays requires thicknesses of materials that may be many times greater than the mean-free-path length.

It will be obvious, then, that the problems involved in providing shielding against neutrons and gamma rays are of far greater severity than those for other particles, and in the design of a reactor installation these two radiations are the only ones to which serious attention need be given. Not all particle energies are of interest, even for gamma rays and neutrons. Photons of energy greater than 10 Mev rarely occur in fission or other neutron-induced processes, and this value can be used as a safe upper limit. The lower boundary is less definite. Certainly, there can be little interest in gamma rays so soft that they do not readily penetrate air or tissue -- energies less than 20 kev. Gamma radiation of somewhat higher energy -- up to several hundred kilovolts -- is easily absorbed in heavy materials and shielding against such sources of radiation is not difficult. However, photons of lower energy may appear as secondaries from harder gamma rays and must be included in determining biological dose. Neutrons of energy as high as 18 Mev have been detected in the fission spectrum, and in reactor shielding design this value can be adopted arbitrarily as an upper limit. At the other end it is necessary to go as low as energies corresponding to thermal agitation, namely thermal neutrons. It has been found, however, that thermal neutrons produce less biological damage for the same flux than fast neutrons and can be stopped quite easily.

Reactor Shielding Design. This brief consideration of the character of nuclear radiation should make clear the fact that shielding design is beset with many complexities; indeed, one has only to examine a new book on "The Attenuation of Gamma Rays and Neutrons in Reactor Shields" by Herbert Goldstein,* to discover how complex the subject really is. The shielding of reactors is a subject which cuts across the boundaries of the conventional fields of science and technology. The fundamental processes involved in the generation and attenuation of nuclear radiation clearly belong in physics, but many other domains are involved. Applied mathematics has contributed much to the solution of the difficult transport problem. Biology plays an obviously important role in establishing the permissible maximum radiation levels. The problems introduced in constructing and cooling the shield and in finding materials with desirable properties bring chemical and and mechanical engineering into the picture. Finally, there is the newest branch of technology -- nuclear engineering -- which though barely weaned from its mother sciences, must shortly assume over-all responsibility for reactor and shield design.

While it is impossible in this short discussion to more than touch upon this vast new field of knowledge, there is an underlying viewpoint in all the procedure which can be stated quite briefly. Essentially it amounts to this; fast neutron capture is a relatively rare reaction, and neutron shielding almost always proceeds first by slowing down the neutrons to thermal or near-thermal energies and capturing them in suitable material. In most cases the major part of the slowing down is accomplished by elastic collision with very light nuclei -- exactly as in the moderation occurring in thermal reactors. Since high thermal capture cross section in shield materials is an advantage rather than a bar, the nucleus of choice for this slowing down process is H^1. However, such light elements are not normally the best material for gamma ray shielding. An efficient shield for the fast neutron component of reactor radiation is therefore often not adequate to shield against the gamma rays present, and material more suited for gamma ray shielding has to be added. Usually, this additional material is composed of the heavier elements, especially lead, which have a particularly high gamma ray absorption. Thus, there comes about a natural separation between the neutron and gamma ray components of the shield. This is not to say that the lighter material has no share in attenuating gamma rays, or that the heavier elements do not contribute to neutron attenuation. But the main brunt of shielding each of the two types of radiation is in general borne by quite distinct portions of the shield. These two portions may be mixed together homogeneously or they may occur in the form of separate layers.

A. W. Kramer

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Price $2.00.

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After well over a year of service in this fabulous community center, the two 15,000-lb. capacity gas-fired Keeler D K Package Steam Generators are still winning highest commendation. *"Performance 100% perfect . . . very economical and up to date . . . operating without trouble"*—are just a few of the comments!

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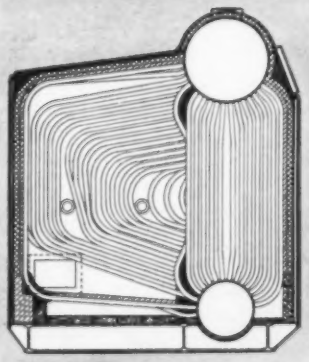

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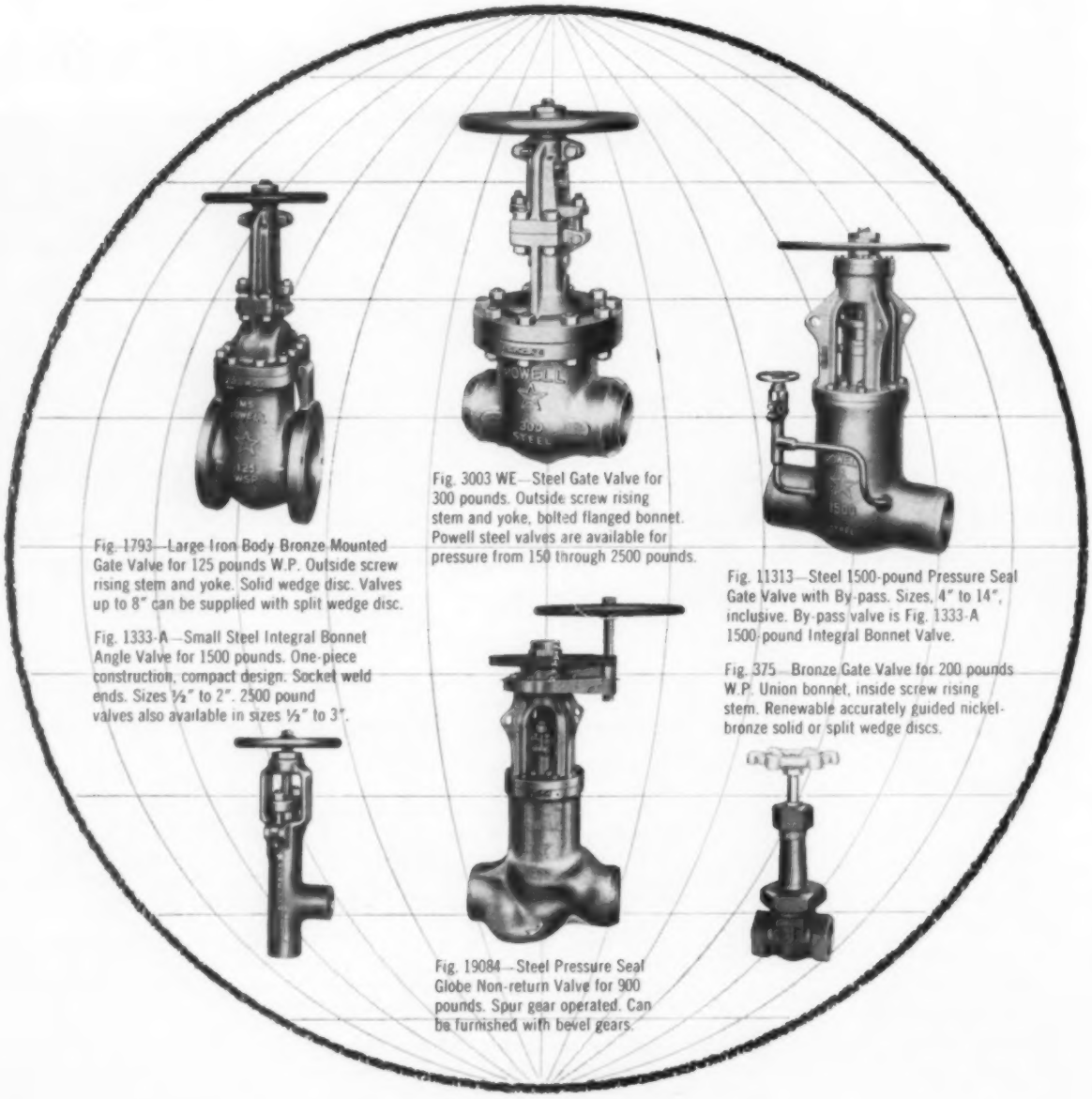

Fig. 1793—Large Iron Body Bronze Mounted Gate Valve for 125 pounds W.P. Outside screw rising stem and yoke. Solid wedge disc. Valves up to 8" can be supplied with split wedge disc.

Fig. 1333-A—Small Steel Integral Bonnet Angle Valve for 1500 pounds. One-piece construction, compact design. Socket weld ends. Sizes ½" to 2". 2500 pound valves also available in sizes ½" to 3".

Fig. 3003 WE—Steel Gate Valve for 300 pounds. Outside screw rising stem and yoke, bolted flanged bonnet. Powell steel valves are available for pressure from 150 through 2500 pounds.

Fig. 19084—Steel Pressure Seal Globe Non-return Valve for 900 pounds. Spur gear operated. Can be furnished with bevel gears.

Fig. 11313—Steel 1500-pound Pressure Seal Gate Valve with By-pass. Sizes, 4" to 14", inclusive. By-pass valve is Fig. 1333-A 1500-pound Integral Bonnet Valve.

Fig. 375—Bronze Gate Valve for 200 pounds W.P. Union bonnet, inside screw rising stem. Renewable accurately guided nickel-bronze solid or split wedge discs.

A solution for every kind of flow control problem is as near as your local Powell distributor. Powell valves are designed and engineered in the largest variety of metals and alloys, to handle any medium, every flow control requirement. There are Powell distributors in all principal cities. Or, if yours is a special engineering problem, write to:

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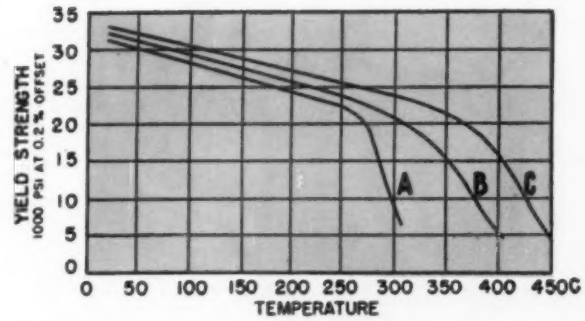
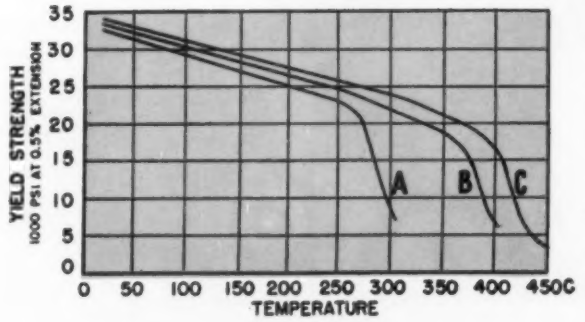
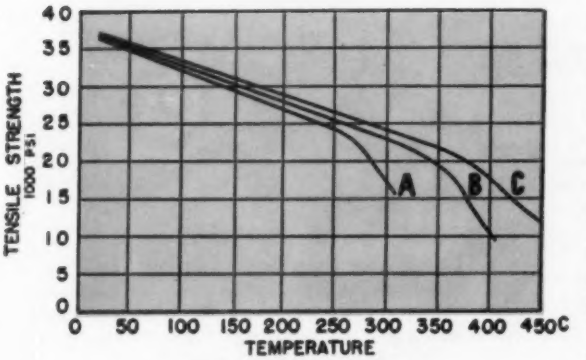
How to give electrical conductors an improved margin of safety at elevated temperatures







A. Silver content normal
B. Silver 8.7 ounces per ton
C. Silver 28. ounces per ton

Copper strips cold rolled,	0.050 ins. gage
Time to heat, approximately	1¼ hours
Time of test at heat, approximately	¼ hour
Speed, testing machine head,	0.01 ins. per min.

American Brass Company Metallurgical Research Laboratory.

Tests show influence of silver on tensile properties of high-conductivity copper at elevated temperatures

Silver-bearing copper is used extensively in windings, collector rings, and commutators of motors and generators, in order to retain structural strength at elevated temperatures during assembly and operation.

There are now many other places where electrical conductors must stand up under temperatures well above those heretofore considered normal.

The amount of silver needed to meet a particular set of conditions, however, has until recently been difficult to determine. At the left are charts summarizing the results of tests made in The American Brass Company Metallurgical Research Laboratory, which can help serve as a more precise guide.

The curves for the yield strengths at 0.2 per cent offset and 0.5 per cent extension are significant to electrical engineers with problems involving the operation of conductors at elevated temperatures, for these values are indices of the limits of elastic behavior. The drop in absolute values of the tensile properties of all three coppers with rising temperature, however, should be noted and be allowed for in the selection of shape and size of conductors that are expected to run hot.

For more complete information on the effect of temperature on the mechanical and electrical properties of copper, send for a copy of Publication C-25, "Anaconda Copper for Electrical Conductors." This 62-page book also has a wealth of other general information, plus convenient new tables to help you in the selection of rigid bus conductors.

Technical Service. The assistance of Anaconda specialists in the selection of conductors to meet your special problems is available to you. For such assistance—or to get a copy of "Anaconda Copper for Electrical Conductors"—see your nearby Anaconda representative. Or write: The American Brass Company, Waterbury 20, Conn. 87101

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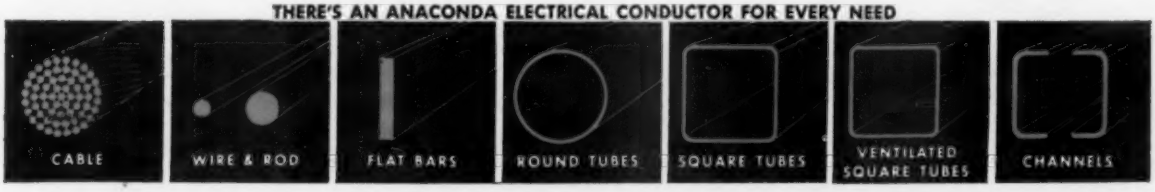

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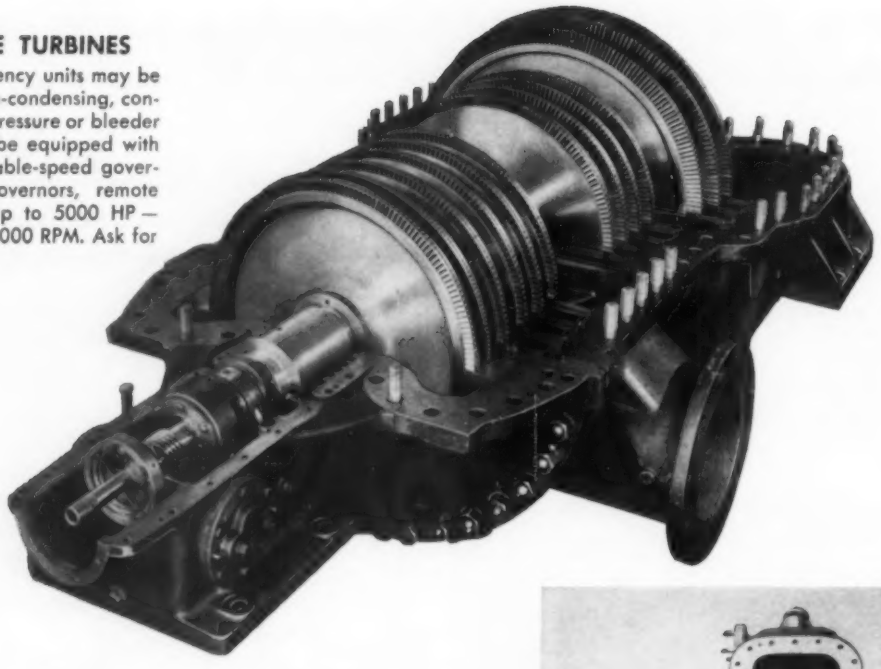
These high-efficiency units may be designed for non-condensing, condensing, mixed pressure or bleeder operation. Can be equipped with constant or variable-speed governors, special governors, remote controls. Sizes up to 5000 HP — Speeds up to 10,000 RPM. Ask for Bulletin S-146.



There's a **Terry turbine** for every mechanical-drive requirement

The designs for Terry turbines are based on more than 50 years of successful experience in the manufacture of turbine drives *exclusively*. This specialization has resulted in Terry becoming one of *the leading producers* of mechanical-drive turbines in sizes up to 5,000 horsepower.

There are three basic reasons why Terry has been able to maintain this position of leadership: (1) a thorough knowledge of the requirements of mechanical-drive turbines, (2) a willingness to build "a little something extra" into each machine to assure trouble-free operation, and (3) an acknowledgement of the company's responsibility to stand behind the performance of every turbine sold.

These are also the reasons why you should consider a Terry turbine for your next mechanical drive. In the meantime, send for bulletins describing any of the types of machines illustrated.

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TERRY

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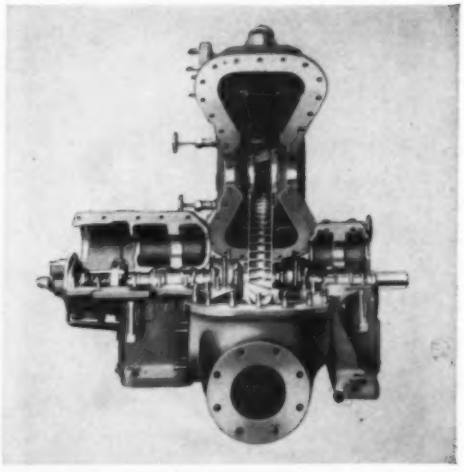

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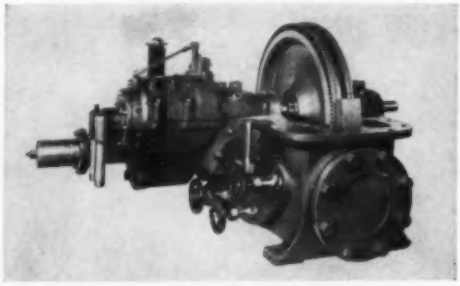

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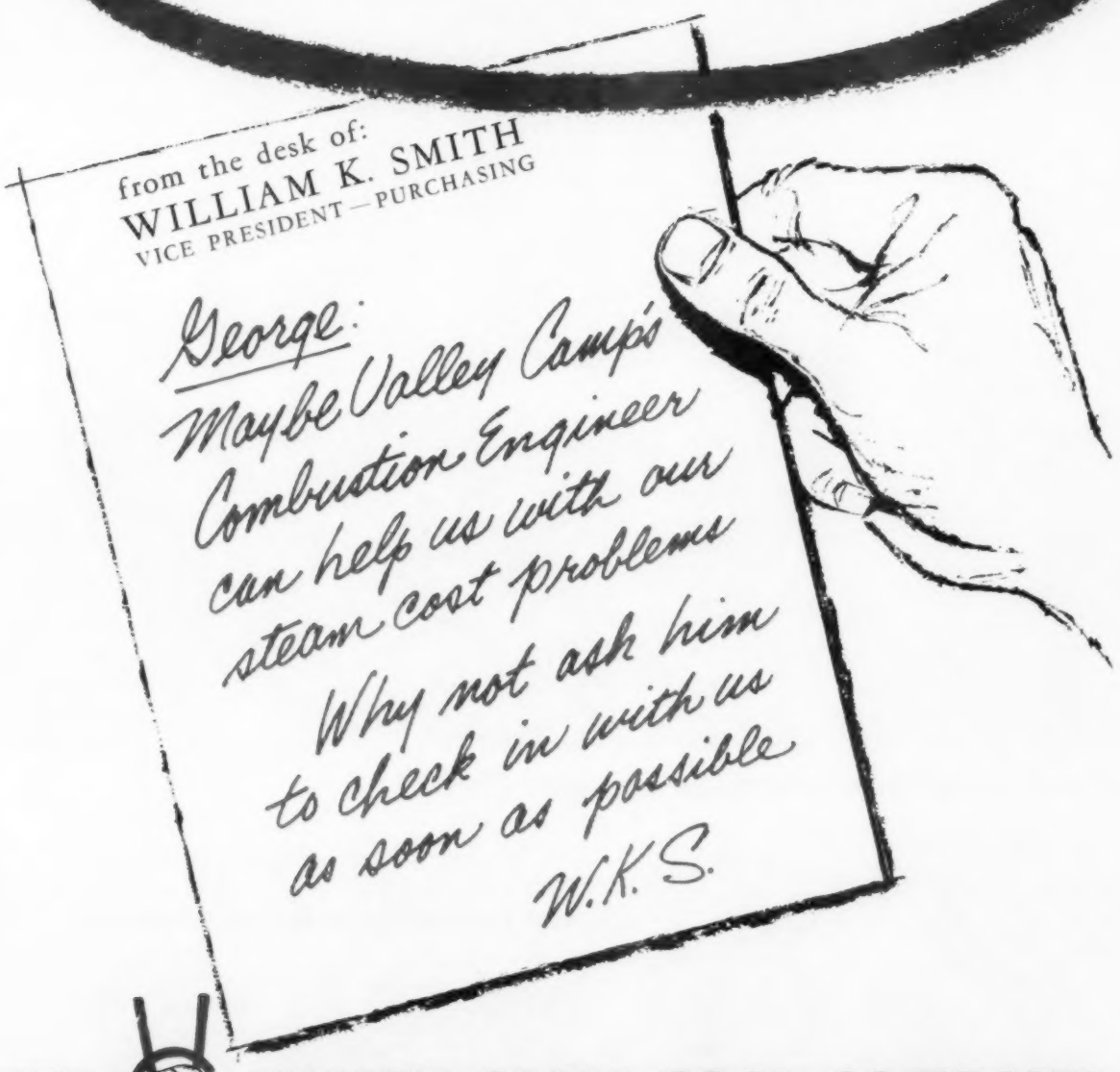
A GOOD NOTE TO REMEMBER;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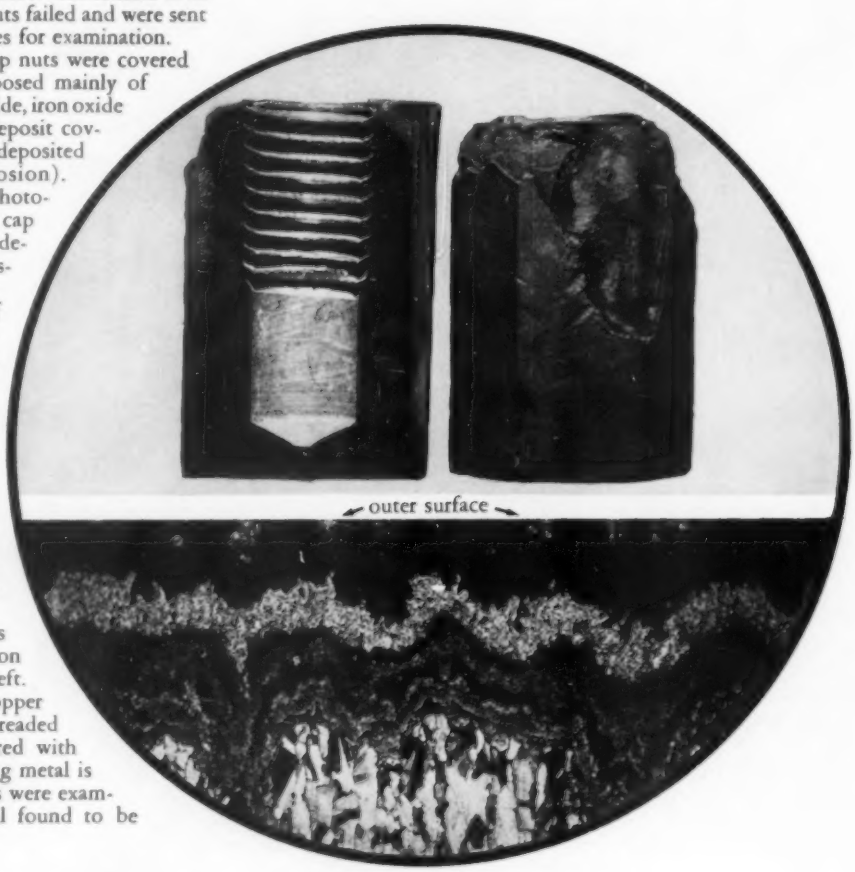
How to prevent CAP NUT failures like this

In a mid-western utilities power station, free-cutting brass cap nuts were used to hold the baffle in the head of a high pressure feed water heater. Unit operates at about 430°F and 1200 lb. pressure. Condensate is in contact with the nuts. These nuts failed and were sent to Revere Research Laboratories for examination.

The outer surfaces of the cap nuts were covered with a thin, black scale composed mainly of copper sulfide, copper oxychloride, iron oxide and copper oxide. The scale deposit covered a thick, uniform layer of redeposited copper (dezincification corrosion). Bottom photo at right shows photomicrograph of a section of the cap nut indicating the extensive dezincification corrosion progressing from the outer surface.

The soft, spongy layer of redeposited copper had penetrated to a depth of about ⅛". Examination disclosed that the initial corrosion is followed by a secondary reaction. Corrosion of a similar nature continues beneath the primary deposit of copper. In this way a brittle, porous copper gradually replaces the sound metal, eventually penetrating the cross-section of the metal, which results in a cracking of the nut.

Top photo of free-cutting brass cap nuts shows outer surface on the right and cross-section at left. Uniform layer of redeposited copper on outer surface is seen at left. Threaded portions of the nuts are covered with thin oxide film, while underlying metal is slightly corroded. Microsections were examined and the uncorroded metal found to be sound and of good quality.



Aluminum Silicon Bronze Logical Choice

Because susceptibility to dezincification corrosion increases with increasing zinc content of an alloy, the corrodent in the condensate responsible for the attack was probably dissolved carbon dioxide. Since neither free-cutting nor Naval brass nuts offer sufficient resistance to dezincification, aluminum silicon bronze would be the logical choice. When exposed to such severe conditions of service, this alloy combines good machinability with high corrosion resistance.*

Because no one alloy can possibly meet all the various conditions of use, Revere makes many different alloys for parts such as this as well as condenser and heat exchanger tubes and plates. Revere furnishes plates, in Cupro-Nickel, Copper, Herculoy, Muntz Metal, Naval Brass and Admiralty, and tubes in Cupro-Nickel, Aluminum Brass, Admiralty, Herculoy, Arsenical Copper, Muntz Metal and other alloys. Consult with Revere's Technical Advisory Service regarding the selection of the alloy best suited to your specific operating conditions.

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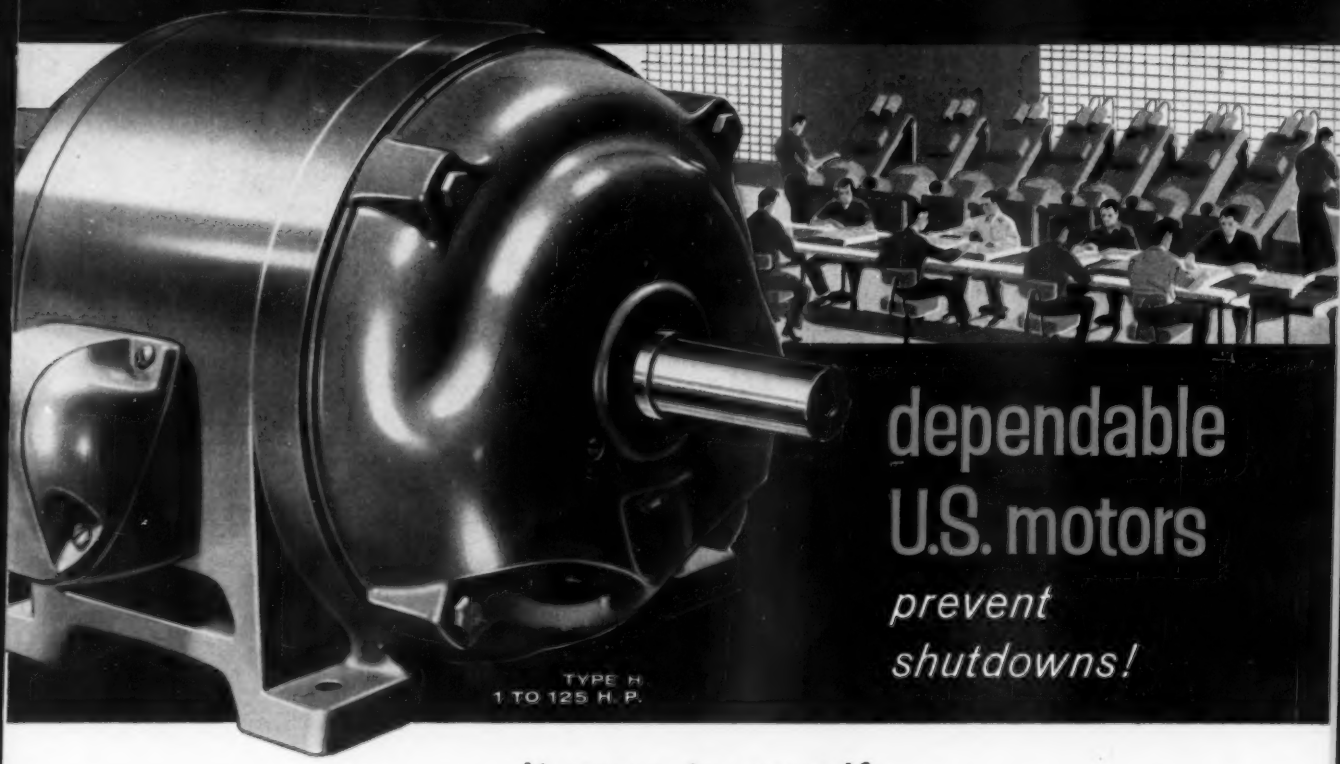
production shutdowns **cost more than motors!**



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Many plants have done it by putting Detroit Stokers under existing boilers—to take advantage of improved combustion efficiency and higher burning rates. Savings and increased steaming capacities are substantial . . . are particularly worth while considering the moderate investment involved.

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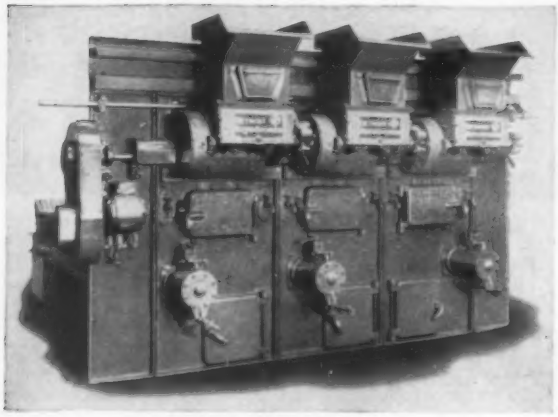

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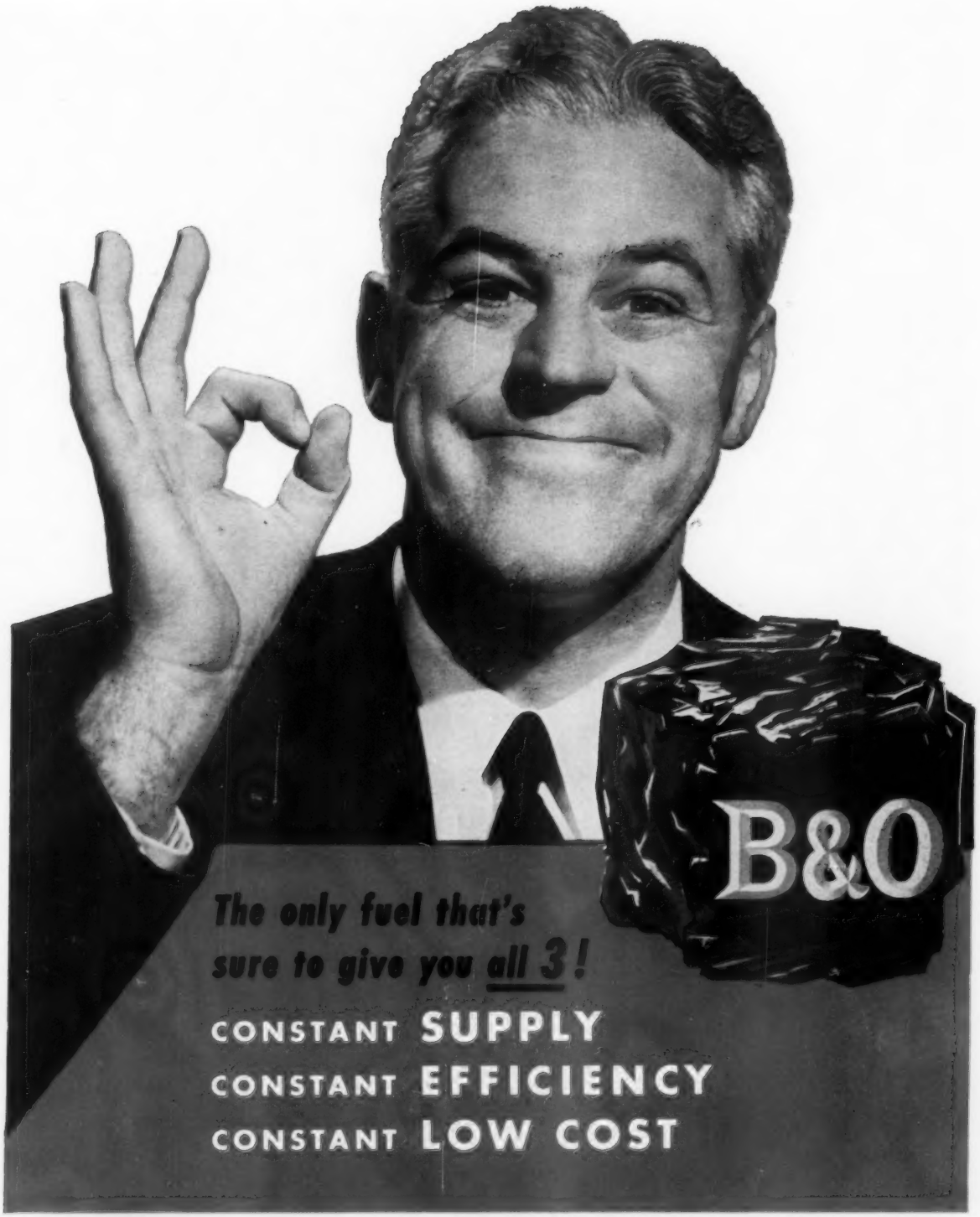

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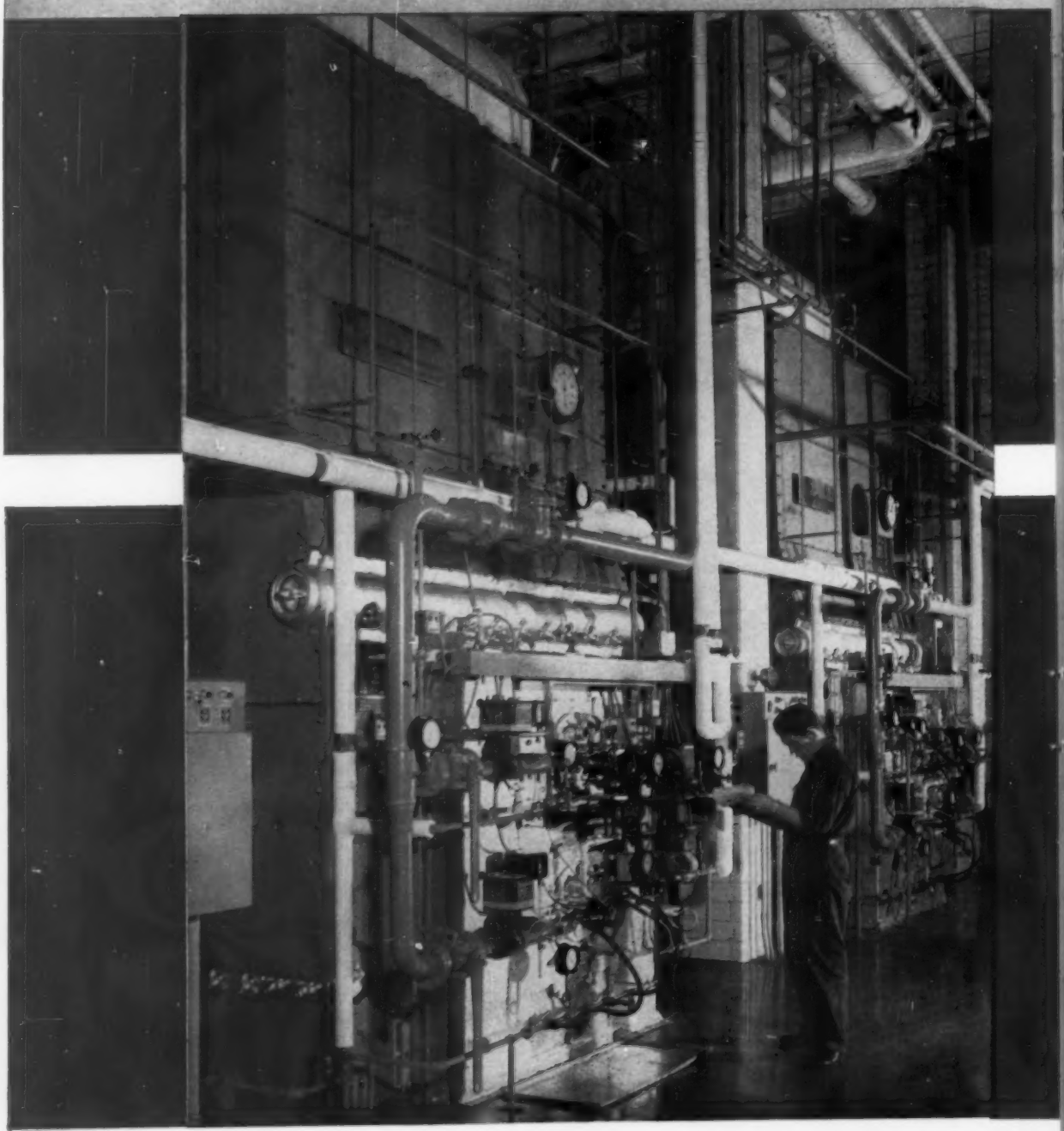

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A recent exhibit at the National Gallery features 10 of America's most modern buildings. The American Institute of Architects, on the occasion of its Centennial, included in the exhibit the new home office of the Connecticut General Life Insurance Company in suburban Hartford, which is equipped with Wickes boilers. This spacious, sun-flooded building of steel and glass, is nearly a modern city in itself, for it houses not only the complete office system, but includes employee lounges, game rooms, medical department, mailrooms, auditorium, bowling alleys, barber and beauty shops as well.

For the heating system in this mammoth structure, engineers chose to install two Wickes type S-1Ab steam generators equipped with both oil and gas burners. In addition to general heating, the steam generators provide power to operate the refrigeration machines and a snow-melting system on the truck ramp. The boilers each have 3700 sq. ft. of heating surface, and were designed for a maximum continuous load of 27,500 pounds of steam per hour at 200 PSIG.

Bulletin No. 55-1 gives complete facts on Wickes products. New engineering bulletins on Type-S and Type-A Steam Generators are also available on request.

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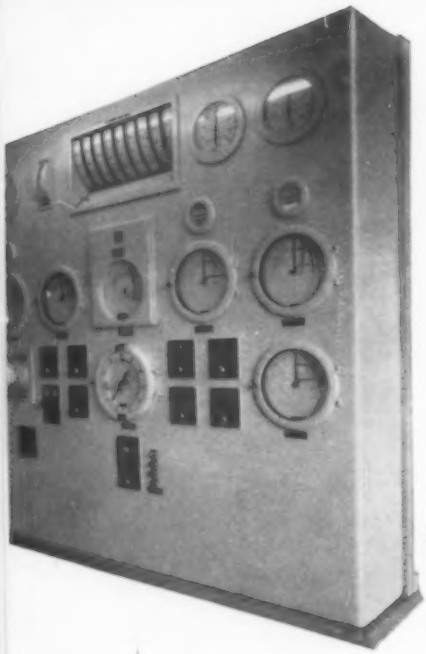
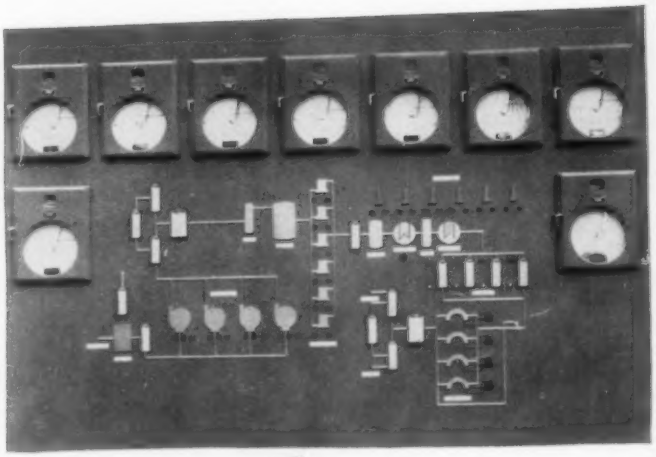
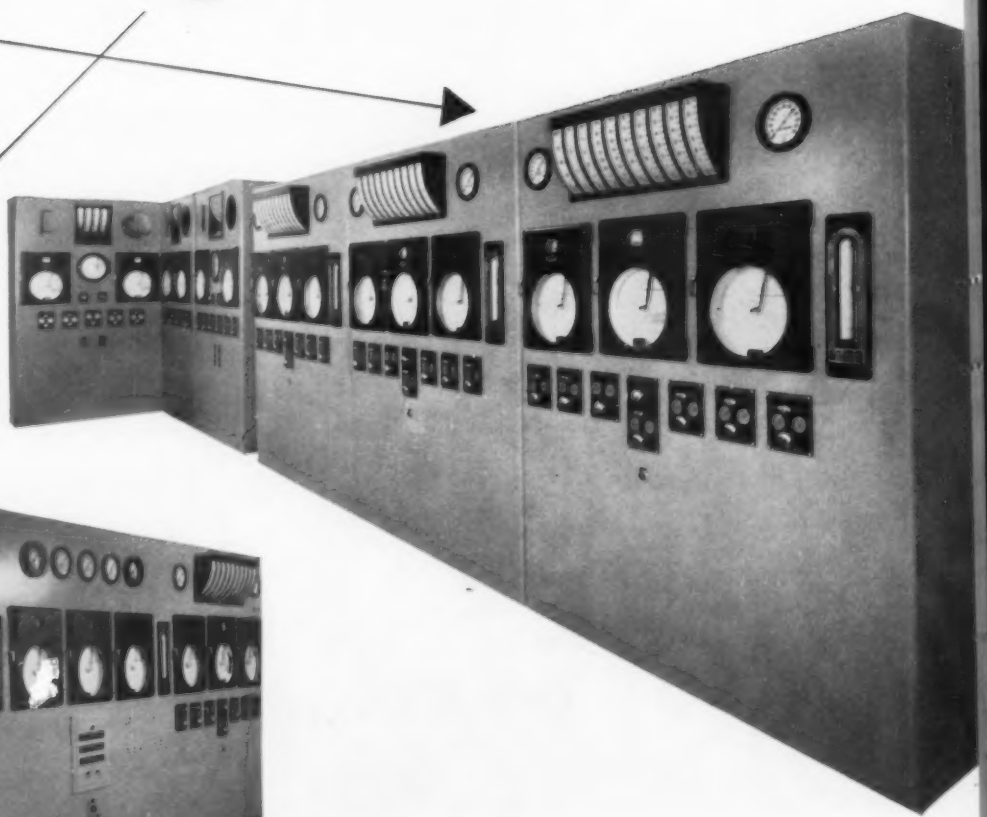
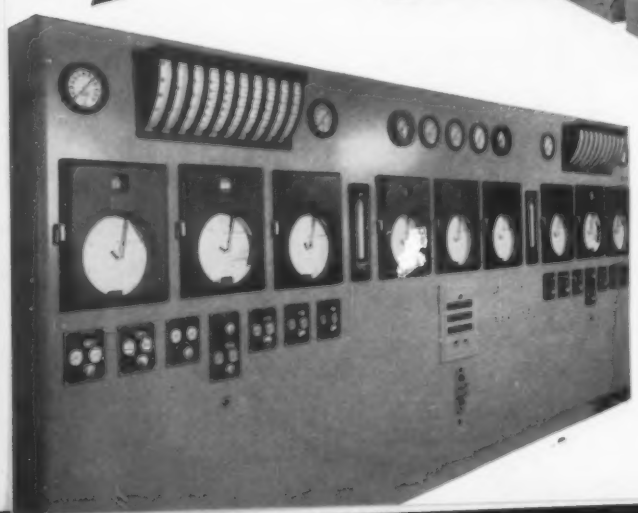
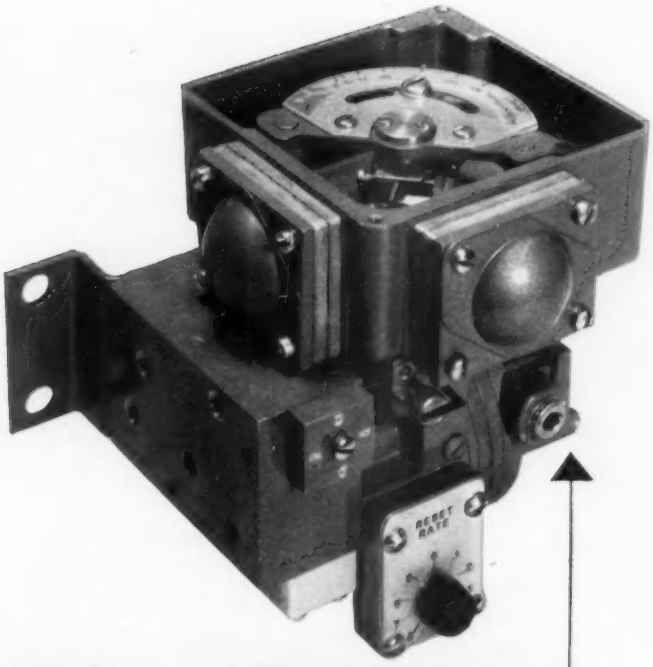




Base Any Of These....







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Here is an all purpose null-balance-vector controller for use with any pneumatic transmitter. Its proportional band ranges from 2% to 500% *without changing parts*, for quick adaptation to changes in process requirements. Especially important in high-precision control, Republic's Type VC has exceptional sensitivity and a narrow dead band (less than 0.05%). Its high capacity non-bleed pneumatic amplifier consumes little air, keeps output ample. A selector block permits reverse or direct action. Local or remote pneumatic set point optional.

Companion instruments—using an identical null-balance-vector "heart"—include differential pressure, temperature and pressure transmitters . . . ratio, totalizing, multiplying, squaring and square - root - extracting relays. Many parts are interchangeable among the instruments in this "family". Besides reducing spare parts inventory, the similarity of components simplifies the task of training personnel.

Let a Republic engineer show you how these instruments can help to achieve accurate, efficient, dependable control systems. Sales offices in principal cities throughout the U.S. and Canada. Write to Republic Flow Meters Company (subsidiary of Rockwell Manufacturing Company), 2240 Diversey Parkway, Chicago 47, Illinois. In Canada: Republic Flow Meters Canada, Ltd., Toronto.

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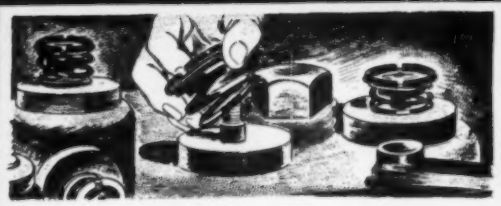

¼ billion flexures in chlorinated water

...Monel check valve springs still springy

IN 1932, 3,450 MONEL CHECK VALVE SPRINGS WERE INSTALLED IN A METROPOLITAN WATER PLANT'S FOUR LARGE PUMPS. PREVIOUSLY, STRESS-CORROSION BECAUSE OF CHLORINE IN THE WATER CAUSED CRACKING AND FAILURE OF SPRINGS, SHORTENED THEIR LIFE TO 3 YEARS OR LESS. TODAY, OVER 90% OF THE ORIGINAL MONEL SPRINGS ARE STILL IN SERVICE, MANY AFTER 25 YEARS AND OVER A QUARTER BILLION FLEXURES.

The metal that comes back from Davy Jones' locker

MONEL ALLOY TAGS CLIPPED TO PUPS' FLIPPERS COME BACK FROM THE DEEP TO TELL A TALE OF THE MIGRATIONS OF SEAL HERDS. THE U.S. FISH AND WILDLIFE SERVICE FINDS MONEL ALLOY RETAINS IDENTIFYING MARKS FOR AS LONG AS 12 YEARS DESPITE SALT-WATER CORROSION AND ABRASION FROM ROCKS AND SAND.

Slowed down by a metal problem?

A TALK WITH ENGINEERS FROM INCO'S MECHANICAL ENGINEERING SECTION MAY HELP YOU GET BACK ON SCHEDULE. JUST GET IN TOUCH WITH US AND OUTLINE THE DETAILS. AND FOR A USEFUL RUN-DOWN ON MONEL ALLOY, WRITE DEPARTMENT **PE** FOR 30-PAGE INCO BULLETIN, "ENGINEERING PROPERTIES OF MONEL AND 'R' MONEL ALLOYS".

THE INTERNATIONAL NICKEL COMPANY, INC.

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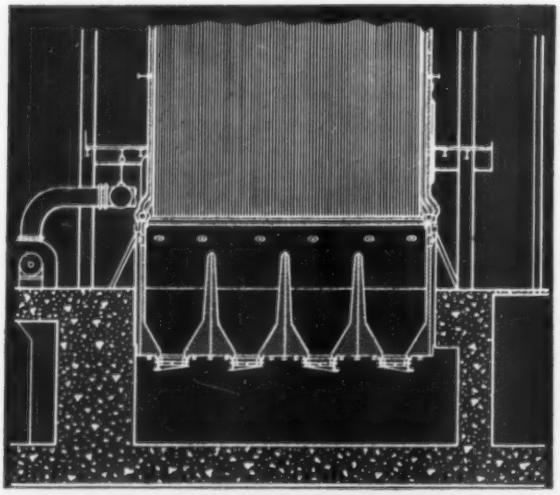
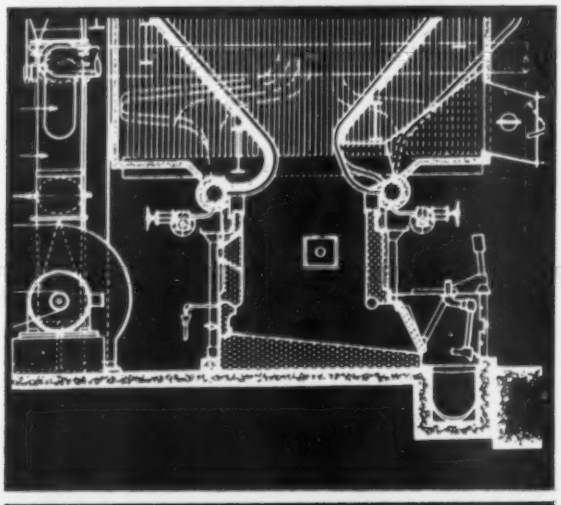
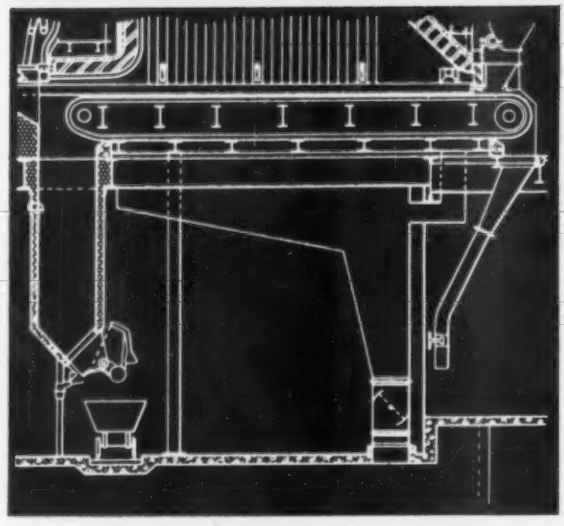


Erosion, due to dry ash sliding down the hopper, is the big problem in this ashpit.



Water jets can cause abrasion of ashpit floor refractories, and water splattered on the walls may cause spalling.



Continuous deposits of ash from a stoker-fired boiler have an abrasive effect on this ashpit lining.

Reduce refractory wear in ashpits with B&W Kaocrete

Relining ashpits is expensive. That's why power engineers specify heavy-duty B&W Kaocrete-D. On job after job, in all types of ashpits, this refractory castable has withstood the heavy abrasive and erosive attacks of sprays, jets, rakes and shovels.

The reason? Specially designed B&W Kaocrete-D has the strength and hardness needed for tough ashpit service. It has unusually high resistance to abrasion, erosion and spalling. It also saves time because it can be cast or gunned in place.

For the facts and figures on Kaocrete-D, as well as Kaocrete-A which is recommended for less severe applications, consult your local B&W Refractories Engineer.

Send for Bulletin R-40 which gives data on B&W Kaocrete Refractory Castables for lining ashpits.

R605

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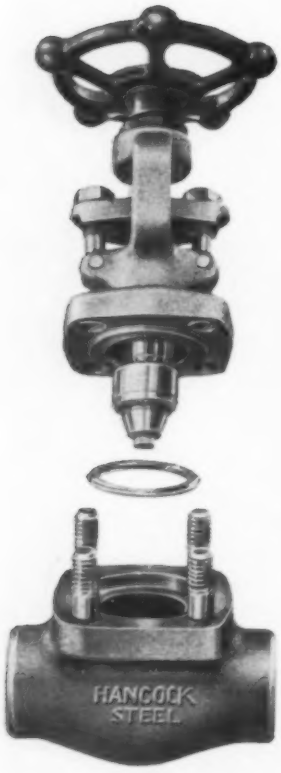

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Hancock 600# Steel Valves incorporate new concepts in valve-ology that reduce valve maintenance and equipment down-time. The forged steel bonnet and body have butting flanges so strong no distortion is possible. The flanges form a bonnet joint that utilizes the sealing power of a Flexitallic* gasket so effectively not even pressures exceeding ten times the rating of the valve can cause a blowout.

Hancock valve-ology makes full use of stainless steel to reduce your valving cost. Seat, disc, stem, swing bolts and nuts, thread bushing, packing gland follower—all are stainless steel. Globe, Angle, "Flocontrol", Lift Check, and Hi-Pressure Drop designs available. A high degree of standardization simplifies servicing and inventory needs. Your industrial supply distributor will gladly give you full details on Hancock Valve quality and performance. Phone him today.

Hancock 600# Steel Globe Valve. Type 5500 Line. Sizes: ¼" thru 2".

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H2-58

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Now WILSON offers a complete line of Torq-Air-Matic automatic tube expander controls. The Wilson Torq-Air-Matic is the first and only air driven tube expander drive that accurately controls tube expansion by directly measuring torque output at the mandrel without depending on frictional, ratcheting, magnetic, hydraulic or electrical devices.

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YARWAY IMPULSE* is the only steam trap that continually samples fluid in the line to maintain condensate discharge close to steam temperature, eliminating condensate as soon as it forms.

Condensate seals the small control orifice against steam leakage under all normal operating conditions.

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1. GETS EQUIPMENT HOT FAST—AND KEEPS IT HOT
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ONLY ONE MOVING PART, A SMALL STAINLESS STEEL VALVE, ACTUALLY "FLOATS" ON THE CONDENSATE LOAD.

Actual size ¾" trap

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TRACERS

Power Engineering's Monthly Probe of Power Facts

Trip of 6000 miles to U. S. Air Force bases in the Azores and Bermuda has given POWER ENGINEERING editors Dick Morris and Bob McCaw a sharp look at diesel generation, electrical distribution and water problems as handled under extremely rigorous conditions. For what they found — watch for early issues of POWER ENGINEERING.

High cost of electricity from atomic power will get a comedown from Pacific Gas & Electric Co's plans for a 60,000-kw atomic power plant near Eureka, Cal. Same size as Shippingport, new plant's capital cost will be $20,000,000, or about $300 per kw as compared with $1200 at Shippingport. Unit power cost is expected to approach 8 mills per kwh, which is economically competitive for the region.

The escalator idea has been adapted to horizontal transportation. Otis Elevator has produced the Trav-o-lator, a series of moving platforms which will carry guests back and forth between two units of a motel and hotel in San Diego, Cal.

Alcoa Aluminum has a new aluminum die casting alloy, with built-in structural and bearing strength, useful for providing integral bearing surfaces instead of cast-in or specially assembled bearings or bushings. It will withstand loads of 1500 psi. First commercial application of alloy X385 is in connecting rods for air conditioning compressors.

Self-regulating distribution transformer, just announced by McGraw-Edison Co, senses voltage at the utilization level and maintains an average secondary voltage of 120 v by actuating a tap charger connected to the primary winding.

Electronic refrigeration — which does away with moving parts — has moved into the practical. Westinghouse is showing a device that can automatically cool or heat a baby's bottle, and a mobile hostess cart with both refrigeration and oven compartments. Principle is simple: a current passed through the junction of two dissimilar metals will produce a cooling effect in the junction. When the current is reversed, the junction produces a heating effect.

First photograph of the atom has been accomplished, by Erwin Müller of Pennsylvania State University, using a microscope he invented himself. Muller has obtained motion pictures of atoms magnified from one million to over three million times their actual size.

Lucas Graphs, presented to the public for the first time on page 64, are one of the outstanding contributions to transmission line calculations in recent years. The result of many years' work by their originator, Robert S. Horn, they indicate, accurately but at a glance, the capacity in kw-miles of any line through a wide range of voltages, power factors, conductor sizes, and voltage drops. Correction tables for variations due to conductor spacing, aluminum, hollow copper, or special conductors, and 50-cycle operation are an added feature.

Figure Your Power Lines Quickly and Accurately with Lucas Graphs

Editor's Note: Over the years, and particularly in his own consulting business, Mr. Horn became increasingly aware of the need for direct-reading charts for the performance characteristics of a large variety of transmission and distribution lines. Several efforts met with undesirable limitations, until he discovered a combination of two things, the log-log type of graph, and the correction tables which made the graphs applicable to almost all pertinent line conditions.

Thousands of man-hours were involved in making, checking and cross-checking the calculations. Each of the five original graphs, covering 10 wire sizes from 4/0 to 8, is 35 in. by 50 in., giving very high accuracy. Twenty-seven values were used in plotting each curve, with calculations extensive enough to limit accumulated error to one part in 1000. Resulting curves are accurate to within one per cent of the line kw-mile capacity indicated. POWER ENGINEERING is proud to present them to our readers—the first public presentation of the Lucas Graphs.

By ROBERT S. HORN *

LUCAS GRAPHS are a means of determining, accurately, the characteristics of various transmission and distribution lines with a minimum of time and effort.

They indicate, with high accuracy, the capacity in kw-miles of any line, with a wide selection of voltages, power factors, conductor sizes, and voltage drops. By fixing any three of these variables, the effect of changing the fourth can be read.

Correction tables for variations due to conductor spacing, aluminum,

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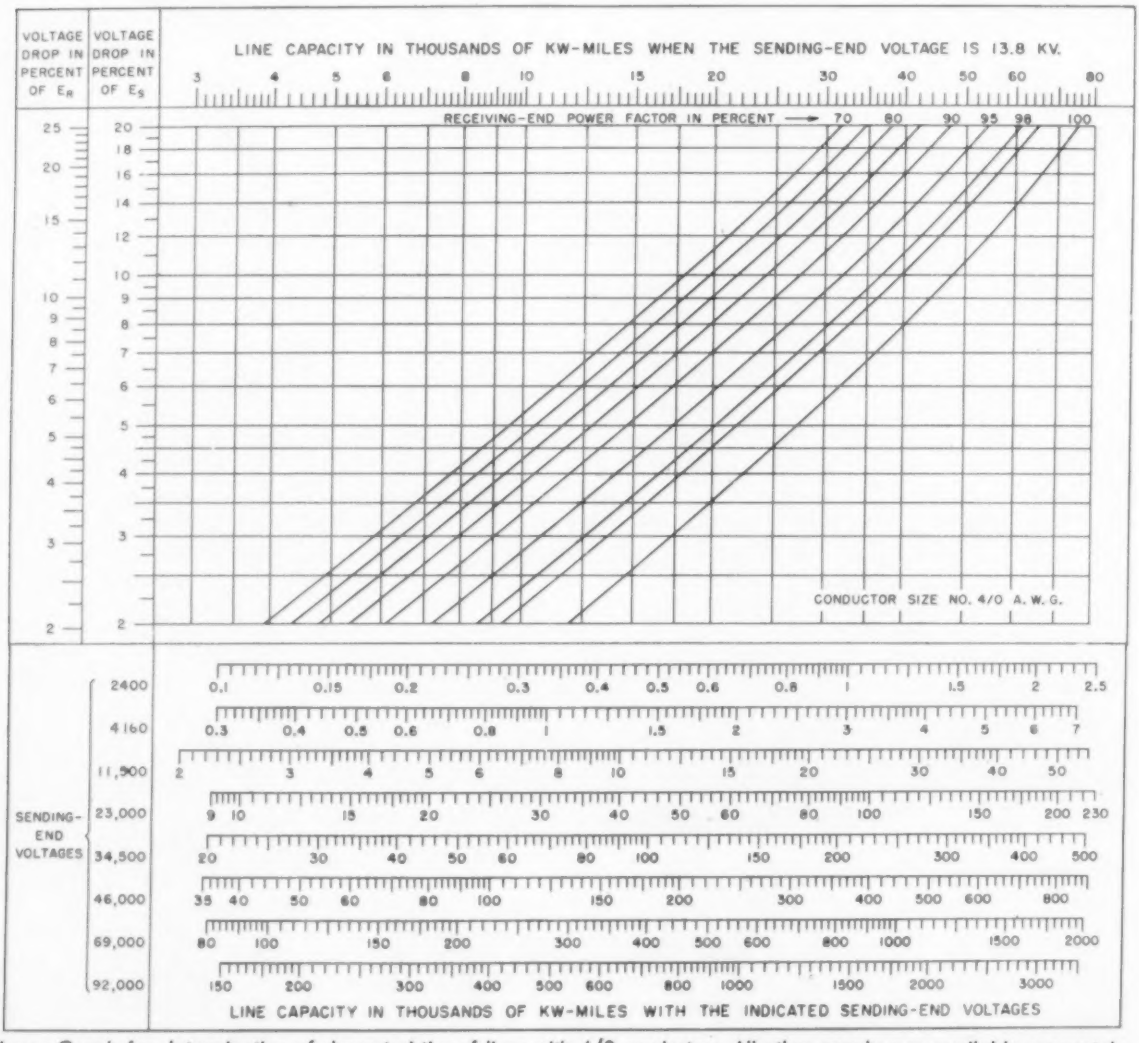

Lucas Graph for determination of characteristics of lines with 4/0 conductors. All other graphs are available separately

hollow-copper, or special conductors, and 50-cycle operation accompany the graphs.

Graphs cover a range of line-voltage drop of 2 to 20 per cent of sending-end voltage, corresponding to 2.04 to 25 per cent of receiving-end voltage.

This large range was selected to provide optimum value in the graphs. Where a line is terminated with a voltage regulator (or a tap-changing transformer) that has a range of plus or minus ten per cent, the regulator can compensate for a voltage drop of as much as 18 per cent of the sending-end voltage.

This percentage is based on the voltage on the load side of the regulator being maintained at a value that is equal to 90 per cent of the sending-end voltage. It is also based on the regulator being utilized throughout its entire plus and minus range when the load changes from full load to no load, with the voltage on the load side of the regulator and the sending-end voltage held constant.

Reading the Graphs

Kilowatt-miles capacity of a line that has any one of the sending-end voltages given on the graphs may be read directly. It may also be obtained for 115 and 138-kv lines by multiplying the values given for 11.5 and 13.8-kv lines by 100. The capacity of a line that has any given sending-end voltage E_{ss}, may be obtained by applying the following formula:

$$\text{Kw-miles with } E_{ss} = \text{Kw-miles with } E_s \left(\frac{E_{ss}}{E_s}\right)^2$$

where E_s is one of the sending-end voltages given on the graphs.

Graphs and Table I are based on a frequency of 60 cycles and pertain to lines that have regular 7-strand copper conductors size No. 4/0 to No. 3, inclusive, and solid copper conductors size No. 4, 6 and 8. The characteristics of these conductors are given in a table accompanying the complete set of graphs.

Graphs are also based on an equivalent conductor spacing of 3 feet. When the equivalent spacing is more or less than 3 feet, Table I may be used for the purpose of correcting the value of line capacity read from the graphs. This table contains values for making the required correction when a line has a conductor spacing that has any one of the values given that are within the range of 1.5 to 20 ft. It gives values of per cent correction that pertain not only to various values of conductor spacing, but also to various values of the power factor of the receiving-end load and line-voltage drop.

These values of per cent correction inherently vary to some extent with voltage drop, and in order to conserve space each value given in Table I pertains to a range of voltage drop. In each case, the range selected is sufficiently small to limit the error in the value given to a maximum of one per cent of the line capacity.

When the conductor spacing is more than 3 ft, the values of the per-cent correction given in Table I indicate a per cent decrease in line capacity. This, of course, is due to the fact that when the spacing is increased the reactance of a line is also increased, which in turn reduces the amount of power that it can transmit with a given voltage drop.

Typical Problem

As an example of the use of the Graphs and Table I combined, let us determine the kilowatt-miles capacity of a line that has an operating frequency of 60 cycles, a sending-end voltage of 69 kv, a voltage drop equal to 12 per cent of the sending-end voltage, a receiving-end power factor of 90 per cent, a length of 40 miles, and size 4/0 regular 7-strand copper conductors that have an equivalent spacing of 8 ft. The graph for a size 4/0 conductor indicates that the capacity of this line would be 790,000 kw-miles if it had an equivalent conductor spacing of 3 ft.

Referring to Table I we find that it indicates that when a line has size 4/0 conductors, a receiving-end power factor of 90 per cent, a voltage drop equal to 12 per cent of the sending-end voltage and an equivalent conductor spacing of 8 ft, it will have 9.7 per cent less capacity than this same line would have if it had an equivalent conductor spacing of 3 ft.

Subtracting 9.7 per cent of 790,000 from 790,000 we obtain the correct kw-miles capacity of this line, which is equal to 790,000 – 76,600 = 713,400 kw-miles. Dividing this amount by the length of this line we obtain its kw-load capacity which is equal to 713,400/40 = 17,840 kw.

Graphs and Table I may be applied to a line that has conductors such as ACSR or hollow-type copper con-

About the Author

After several years in electrical machine design, Mr. Horn went with Bethlehem Steel as an electrical engineer. In 1941, he became a consultant to the Armed Services, and then the head of a large engineering department in Hawaii. While there he designed one of the first portable generators to deliver a d-c pulse of 70,000 amps.

After the war he spent six years in Japan with Hq Fifth Air Force, broken only by two years with the Navy on Guam. He is now a consulting engineer in Nagoya, where he has done most of the work on the Lucas Graphs.

Table I. Correction factors for use with lines having various values of conductor spacing in the range of 1.5 to 20 feet

CONDUCTOR SIZE A.W.G.	RECEIVING-END POWER FACTOR IN %	VOLTAGE DROP IN % OF E_S	EQUIVALENT SPACING OF LINE CONDUCTORS IN FEET																					
			1.5	1.75	2	2.25	2.5	2.75	3	3.5	4	4.5	5	5.5	6	7	8	9	10	11	12	14	16	18	20
			PERCENT INCREASE IN LINE CAPACITY IN KW-MILES							PERCENT DECREASE IN LINE CAPACITY IN KW-MILES														
4/0	100	2 TO 3	1.2	0.9	0.7	0.5	0.3	0.2	0	0.3	0.5	0.7	0.9	1.1	1.3	1.6	1.9	2.1	2.3	2.5	2.7	3.0	3.3	3.5	3.7
		3 " 4	1.6	1.3	0.9	0.7	0.4	0.2	0	0.4	0.7	1.0	1.2	1.5	1.7	2.1	2.4	2.7	3.0	3.3	3.5	3.9	4.3	4.6	4.9
		4 " 6	2.1	1.7	1.3	0.9	0.6	0.3	0	0.5	0.9	1.3	1.6	2.0	2.2	2.8	3.2	3.6	3.9	4.3	4.6	5.1	5.5	5.9	6.3
		6 " 8	2.8	2.2	1.6	1.2	0.7	0.4	0	0.6	1.2	1.7	2.1	2.5	2.9	3.5	4.0	4.5	5.0	5.4	5.7	6.4	6.9	7.4	7.8
		8 " 11	3.5	2.7	2.0	1.4	0.9	0.4	0	0.8	1.4	2.0	2.6	3.0	3.5	4.2	4.9	5.5	6.0	6.5	6.9	7.7	8.3	8.9	9.4
		11 " 15	4.3	3.3	2.5	1.8	1.1	0.5	0	0.9	1.8	2.5	3.1	3.7	4.2	5.1	5.9	6.6	7.2	7.7	8.2	9.1	9.8	10.5	11.1
		15 " 20	5.1	4.0	3.0	2.1	1.3	0.6	0	1.1	2.1	2.9	3.6	4.3	4.9	6.0	6.9	7.6	8.3	9.0	9.5	10.5	11.4	12.1	12.7
	98	2 TO 6	4.8	3.7	2.8	1.9	1.2	0.6	0	1.0	1.9	2.6	3.3	3.9	4.4	5.4	6.2	6.9	7.5	8.0	8.5	9.4	10.2	10.8	11.4
		6 " 12	5.5	4.3	3.2	2.2	1.4	0.7	0	1.2	2.2	3.0	3.8	4.5	5.1	6.2	7.1	7.9	8.6	9.2	9.8	10.7	11.6	12.3	13.0
		12 " 20	6.4	4.9	3.7	2.8	1.6	0.8	0	1.3	2.5	3.5	4.3	5.1	5.8	7.0	8.0	8.9	9.7	10.4	11.1	12.2	13.1	13.9	14.6
	95	2 TO 10	6.3	4.9	3.6	2.5	1.6	0.8	0	1.3	2.4	3.4	4.2	5.0	5.7	6.8	7.8	8.7	9.5	10.2	10.8	11.8	12.7	13.5	14.2
		10 " 20	7.2	5.5	4.1	2.9	1.8	0.9	0	1.5	2.7	3.8	4.8	5.6	6.4	7.7	8.8	9.8	10.6	11.4	12.0	13.2	14.2	15.1	15.8
	90	2 TO 10	7.5	5.8	4.3	3.0	1.9	0.9	0	1.5	2.8	4.0	4.9	5.8	6.6	7.9	9.1	10.1	10.9	11.7	12.4	13.6	14.6	15.4	16.2
		10 " 20	8.1	6.2	4.6	3.2	2.0	1.0	0	1.7	3.0	4.2	5.3	6.2	7.0	8.5	9.7	10.7	11.7	12.6	13.2	14.5	15.5	16.5	17.3
	85	2 TO 20	8.6	6.6	4.9	3.4	2.1	1.0	0	1.7	3.2	4.4	5.5	6.5	7.4	8.9	10.1	11.2	12.2	13.0	13.8	15.1	16.2	17.1	18.0
	80	" " "	9.2	7.0	5.2	3.6	2.3	1.1	0	1.8	3.4	4.7	5.9	6.9	7.8	9.4	10.7	11.8	12.8	13.7	14.5	15.9	17.0	18.0	18.8
	75	" " "	9.7	7.4	5.5	3.8	2.4	1.1	0	1.9	3.5	4.9	6.1	7.2	8.1	9.8	11.2	12.3	13.4	14.3	15.1	16.5	17.7	18.7	19.6
	70	" " "	10.1	7.7	5.7	4.0	2.5	1.2	0	2.0	3.7	5.1	6.4	7.5	8.5	10.1	11.6	12.8	13.8	14.8	15.6	17.1	18.3	19.3	20.2

Table II. Modified values of conductor spacing for use with graphs and Table I when figuring aluminum or other conductors

DIFFERENCE IN CONDUCTOR REACTANCE PER MILE AT 60 C.R.S. WITH A SPACING OF ONE FOOT	EQUIVALENT SPACING OF LINE CONDUCTORS IN FEET																					
	1.5	1.75	2	2.25	2.5	2.75	3	3.5	4	4.5	5	5.5	6	7	8	9	10	11	12	14	16	18	20
	MODIFIED VALUES OF EQUIVALENT SPACING IN FEET FOR USE WITH TABLE 1																						
−0.10								1.5	1.8	2.0	2.2	2.4	2.6	3.1	3.5	3.9	4.4	4.8	5.3	6.1	7.0	7.9	8.8
−0.09								1.7	1.9	2.1	2.4	2.6	2.9	3.3	3.8	4.3	4.8	5.2	5.7	6.7	7.6	8.6	9.5
−0.08							1.6	1.8	2.1	2.3	2.6	2.8	3.1	3.6	4.1	4.7	5.2	5.7	6.2	7.2	8.3	9.3	10.3
−0.07						1.5	1.7	2.0	2.2	2.5	2.8	3.1	3.4	3.9	4.5	5.1	5.6	6.2	6.7	7.9	9.0	10.1	11.2
−0.06					1.5	1.7	1.8	2.1	2.4	2.7	3.0	3.4	3.7	4.3	4.9	5.5	6.1	6.7	7.3	8.5	9.8	11.0	12.2
−0.05				1.5	1.7	1.8	2.0	2.3	2.6	3.0	3.3	3.6	4.0	4.8	5.3	6.0	6.6	7.3	7.9	9.3	10.6	11.9	13.2
−0.04				1.6	1.8	2.0	2.2	2.5	2.9	3.2	3.6	4.0	4.3	5.0	5.8	6.5	7.2	7.9	8.6	10.1	11.5	12.9	14.4
−0.03			1.6	1.8	2.0	2.1	2.3	2.7	3.1	3.5	3.9	4.3	4.7	5.5	6.2	7.0	7.8	8.6	9.4	10.9	12.5	14.1	15.6
−0.02		1.5	1.7	1.9	2.1	2.3	2.5	3.0	3.4	3.8	4.2	4.7	5.1	5.9	6.8	7.6	8.5	9.3	10.2	11.9	13.6	15.3	17.0
−0.01		1.6	1.8	2.1	2.3	2.5	2.8	3.2	3.7	4.1	4.6	5.1	5.5	6.4	7.4	8.3	9.2	10.1	11.1	12.9	14.7	16.6	18.4
+0.01	1.6	1.9	2.2	2.4	2.7	3.0	3.3	3.8	4.3	4.9	5.4	6.0	6.5	7.6	8.7	9.8	10.9	11.9	13.0	15.2	17.4	19.5	
+0.02	1.8	2.1	2.4	2.7	2.9	3.2	3.5	4.1	4.7	5.3	5.9	6.5	7.1	8.3	9.4	10.6	11.8	13.0	14.2	16.5	18.9		
+0.03	1.9	2.2	2.6	2.9	3.2	3.5	3.8	4.5	5.1	5.8	6.4	7.0	7.7	9.0	10.2	11.5	12.8	14.1	15.4	17.9			
+0.04	2.1	2.4	2.8	3.1	3.5	3.8	4.2	4.9	5.6	6.3	7.0	7.6	8.3	9.7	11.1	12.5	13.9	15.3	16.7	19.5			
+0.05	2.3	2.6	3.0	3.4	3.8	4.2	4.5	5.3	6.0	6.8	7.5	8.3	9.1	10.6	12.1	13.6	15.1	16.6	18.1				
+0.06	2.5	2.9	3.3	3.7	4.1	4.5	4.9	5.7	6.6	7.4	8.2	9.0	9.8	11.5	13.1	14.8	16.4	18.0	19.7				
+0.07	2.7	3.1	3.6	4.0	4.5	4.9	5.3	6.2	7.1	8.0	8.9	9.8	10.7	12.5	14.2	16.0	17.8	19.6					
+0.08	2.9	3.4	3.9	4.4	4.8	5.3	5.8	6.8	7.7	8.7	9.7	10.6	11.6	13.5	15.5	17.4	19.3						
+0.09	3.1	3.7	4.2	4.7	5.2	5.8	6.3	7.3	8.4	9.4	10.5	11.5	12.6	14.7	16.8	18.9							
+0.10	3.4	4.0	4.6	5.1	5.7	6.3	6.8	8.0	9.1	10.3	11.4	12.5	13.7	16.0	18.2								

ductors by applying a modified value of equivalent spacing to Table I. The use of a modified value of spacing rather than the actual equivalent spacing is required because these conductors have either more or less reactance, as the case may be, than the reactance of their equivalent size regular copper conductors upon which the graphs and Table I are based.

Table II contains modified values of equivalent spacing that are for this purpose. In this case a modified value of equivalent spacing, obtained from this table, is to be applied to Table I rather than the actual equivalent value of the conductor spacing in question.

A modified equivalent value of spacing is the spacing that gives the equivalent-size copper conductor, the same value of series inductive reactance as that of, for example, a hollow-type copper conductor or an aluminum conductor with its actual equivalent spacing.

An example of the use of Table II is as follows:

A line has size No. 4/0 hollow-type copper conductors with an equivalent spacing of 8 ft. The reactance of these conductors is 0.444 ohms per mile at 60 cycles with a spacing of one ft. The reactance of a size No. 4/0 regular 7-strand copper conductor at 60 cycles with a spacing of one ft is 0.504 ohms per mile. Subtracting 0.504 from 0.444 gives a difference value of −0.060 ohms per mile.

Locate the quantity −0.060 in the column at the left end of Table II, and read the corresponding modified value of conductor spacing of 4.9 ft, located horizontally opposite the value of −0.060 and vertically below the equivalent value of conductor spacing of 8 ft. The modified spacing of 4.9 ft, which may be taken as 5 ft, is the correct spacing to use with Table I in this case instead of 8 ft which is the actual equivalent spacing.

Lucas graphs are also applicable to 50-cycle lines by applying modified values of equivalent spacings to Table I. Modified values that correspond to various values of equivalent spacing that are within the range of 1.5 to 20 ft are given in Table III for this purpose. These values pertain to 50-cycle lines that have regular 7-strand and solid-copper conductors upon which the Graphs and Table I are based.

Power Factor Correction

A vivid illustration of the effect of power factor on line capacity is readily obtained from the Lucas Graphs. They graphically point out the gain in line capacity that may be obtained by improving the power factor of the receiving-end load.

For example, from the Graph in Fig. 1, it may be quickly seen that the kw-miles capacity for 4/0 conductors is increased more by correcting the receiving-end load power factor from 98 to 100 per cent, than by correcting it from 70 to 80 per cent!

In summarizing it may be said that the Lucas Graphs combined with the accompanying tables provide a means of determining the kilowatt-miles capacity of a large variety of lines. The capacity of any line to which they pertain may be determined in a small fraction of the time required for calculations using any method known to the writer that has an accuracy that is comparable with that obtainable with these graphs and tables. An error of one per cent in the determination of line capacity in kilowatts corrpesonds to an error in voltage drop that is equal to approximately $\frac{1}{20}$, $\frac{1}{10}$ and $\frac{1}{5}$ of one per cent of the line voltage when the line voltage drop is 5, 10 and 20 per cent respectively.

Single copies of the full set of Lucas Graphs are available without charge. Write The Editor, or jot Lucas Graphs on the postcard included in this issue. Quantity prices on request. Also included in the reprint is further background information, and the exact characteristics of the copper conductors on which the calculations were based. THE END

Table III. Modified values of conductor spacing for use when applying the graphs and Table I to 50-cycle line calculations

CONDUCTOR SIZE A.W.G.	EQUIVALENT SPACING OF LINE CONDUCTORS IN FEET																						
	1.5	1.75	2	2.25	2.5	2.75	3	3.5	4	4.5	5	5.5	6	7	8	9	10	11	12	14	16	18	20
	MODIFIED VALUES OF EQUIVALENT SPACING IN FEET FOR USE WITH TABLE 1																						
4/0	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.6	1.8	1.9	2.1	2.2	2.5	2.8	3.1	3.4	3.7	4.0	4.5	5.1	5.6	6.1
3/0	0.7	0.8	0.9	1.0	1.1	1.1	1.2	1.4	1.6	1.7	1.9	2.0	2.2	2.5	2.8	3.1	3.3	3.6	3.9	4.4	4.9	5.5	6.0
2/0	0.7	0.8	0.9	0.9	1.0	1.1	1.2	1.4	1.5	1.7	1.8	2.0	2.1	2.4	2.7	3.0	3.3	3.6	3.8	4.3	4.9	5.4	5.8
1/0	0.7	0.8	0.8	0.9	1.0	1.1	1.2	1.3	1.5	1.7	1.8	2.0	2.1	2.4	2.7	2.9	3.2	3.5	3.7	4.3	4.8	5.3	5.7
1	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.5	1.6	1.8	1.9	2.1	2.3	2.6	2.8	3.2	3.4	3.7	4.2	4.7	5.2	5.6
2	0.6	0.7	0.8	0.9	1.0	1.1	1.1	1.3	1.4	1.6	1.7	1.9	2.0	2.3	2.6	2.8	3.1	3.4	3.6	4.1	4.6	5.1	5.5
3	0.6	0.7	0.8	0.9	1.0	1.0	1.1	1.3	1.4	1.6	1.7	1.8	2.0	2.3	2.5	2.8	3.0	3.3	3.5	4.0	4.5	5.0	5.4
4	0.6	0.7	0.8	0.9	0.9	1.0	1.1	1.2	1.4	1.5	1.7	1.8	1.9	2.2	2.5	2.7	3.0	3.2	3.4	3.9	4.4	4.8	5.3
6	0.6	0.7	0.7	0.8	0.9	1.0	1.0	1.2	1.3	1.5	1.6	1.7	1.9	2.1	2.4	2.6	2.8	3.1	3.3	3.8	4.2	4.6	5.1
8	0.6	0.6	0.7	0.8	0.9	0.9	1.0	1.1	1.3	1.4	1.5	1.7	1.8	2.0	2.3	2.5	2.7	3.0	3.2	3.6	4.0	4.5	4.9

Fig. 1. Recent view of construction progress at Eddystone on No. 2 turbine and boiler rooms for 325,000-kw unit

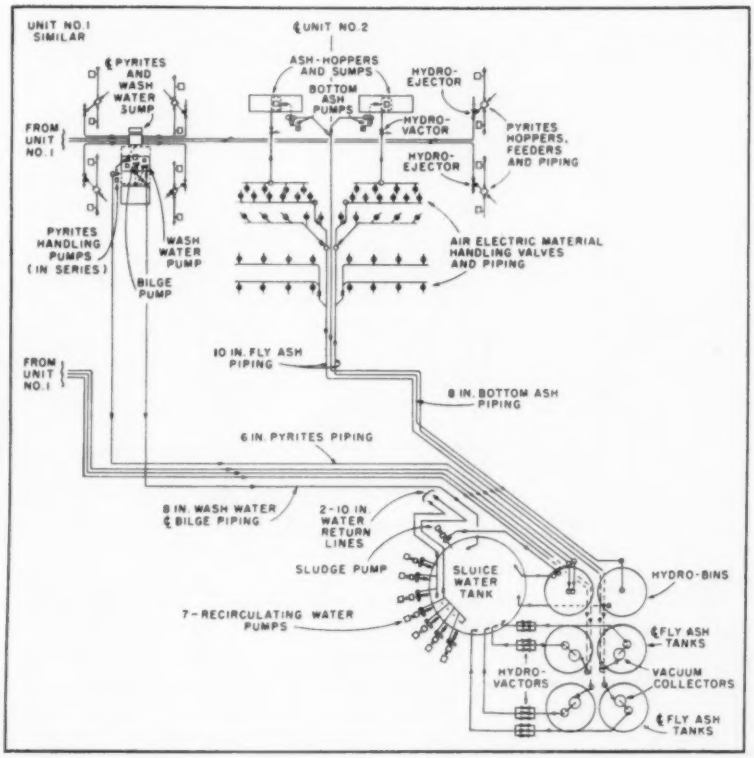

Fig. 2. Ash disposal area (r) is 900 ft from plant. System can handle 80 tons of fly ash per hour at full operation

Eddystone Has Longest Vacuum Ash System

EDDYSTONE STATION, new Philadelphia Electric Company generating station, is located southwest of Philadelphia on the Delaware River near Chester. It is at the converging point of a small waterway known as Crum Creek and the Delaware River. This station houses two supercritical pressure turbine-generator units each having 325,000-kw capacity. First unit is scheduled for operation in 1959, the second early in 1960.

This station represents a progressive step in power production through the use of temperatures and pressures never before attempted. Less than ⅔-lb of coal will be needed to produce 1 kwh of electricity, contrasted with a national average of slightly less than 1 lb. No. 1 Unit will be at a supercritical pressure of 5000 psi and 1200 F temperature. No. 2 Unit will be at 3500 psi and 1050 F. Reheat at 1050 F will be used on both units.

About 5000 tons of coal will be used daily for both units. Based on a percentage of 80 per cent fly ash and 20 per cent bottom ash, this will result in 400 tons per 24-hour day of fly ash to be handled, and 100 tons per day of bottom ash to be handled.

Estimate reveals 24 tons of pyrites will be handled per 24-hour day.

Ash disposal area has been located approximately 900 ft from the plant proper for the following reasons: 1. this will keep all ash problems entirely remote from the plant; 2. it will permit removing bottom ash and fly ash by means of railroad cars, trucks or barges anchored in Crum Creek.

This is reputedly the longest vacuum handling system for fly ash ever attempted. It was supplied by Allen-Sherman-Hoff.

Each boiler is served by two ash bottom hoppers of the water-filled type. Ash is then pumped out to dewatering bins. Overflow water from the bins is collected in a sluice tank. This water is then reused in the system by means of high pressure pumps. System is entirely closed, with no run-off water whatever. It is possible to operate the bottom ash system on both boilers simultaneously, giving a total handling capacity of 120 tons per hour.

Fly ash is transported by a vacuum producing system. Each boiler is divided into two halves with an independent system for each half. It is arranged to operate any pair of systems simultaneously. Each system is capable of handling 40 tons of fly ash per hour, or a total of 80 tons per hour with two systems in operation. The system is entirely automatic, controlled by a sequential automatic control panel. Fly ash will be collected by primary and secondary collectors on top of four large storage tanks. Vacuum will be produced by water jet pumps. Water will be discharged into the sluice tank and recirculated as shown in the diagram.

The pyrites handling system is fully automatic and will be transported by means of a high pressure hydraulic system to a sump. The pyrites will be pumped from the sump to one of the dewatering bins and mixed with the bottom ash.

All phases of operation of the bottom ash, pyrites and fly ash are fully automatic. Each ash pit is equipped with a closure door beneath the bottom of the ash pit and the sump. Beneath the closure door is a metering ash grinder for properly sizing the material to the hydraulic lines in the bottom ash system.

It is necessary on the Eddystone units to be able to wash down certain portions of the boiler. This will require a pumping capacity of 4800 gpm at certain times. This water will be discharged by gravity means to a sluice trench in the floor. This trench will then run into the sump located midway between the two units. It will then be pumped from this point to the sluice tank. THE END

Will Your

By PAUL N. GARAY *

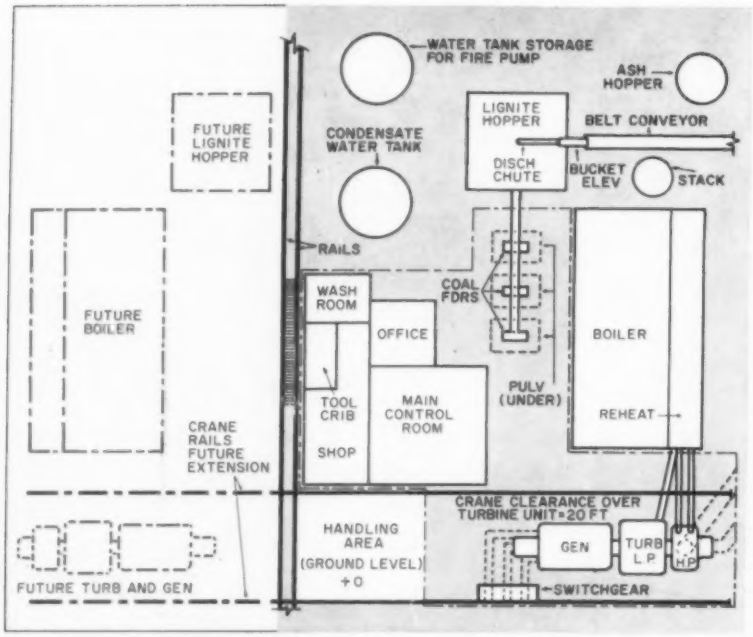

Fig. 1. Do the plans provide for future additions at least cost and minimum disruption? Is operating level spacious and uncluttered? How about maintenance?

THERE ARE MANY areas in which modern technology can be applied profitably. Let us first consider the temperature and pressure cycles of new power and process plants.

For the time being it appears that the near critical and supercritical plants which we have built are at the economical maximum temperature and pressure conditions. Until some well-defined break-through in metallurgy or technique is achieved, anything in excess of what we have now achieved will cost more than its potential return. This is the reason why the gas turbine used to top a steam cycle is being viewed with such interest. The savings possible with a combined gas turbine and steam cycle have been extensively discussed, but the application is not common.

The gas turbine, of course, will add most to the efficiency of the higher temperature and pressure designs. An 850-psig 900-F cycle may be improved by 5.35 per cent, but a 1450-psig 1000-F/1000-F reheat cycle will show a gain of 11.1 per cent in efficiency. In cases where physical size factors are important, the combined cycle requires less space than the simple, due principally to the reduction in the size of the boiler required.

Cost comparisons based on a 44,000-kw generating plant show that in this size range the gas turbine plant costs 1½ per cent more, but has a 7.4 per cent better heat rate. Heat rate improvement is possible at any load over 30 per cent of full capacity. The combined cycle will show best efficiency at about 75 per cent; below this load the efficiency decreases quite rapidly. However, in addition to the problems of operating complexity, the gas turbine requires a constant supply of high grade fuel, low in sodium and vanadium content.

In connection with a steam cycle, or even as a power generating unit, have you considered the free-piston gas generator? Here is a new unit whose only fault is that to obtain capacities in excess of 1000 kw, multiple units must be used. However, their qualifications are many. They are cheap, compact, reliable, insensitive to fuel and air temperature conditions, and have efficiency comparable to the best diesel, while still using a low temperature gas turbine. Good part-load efficiency can be achieved by using multiple units, cutting them in or out as necessary. As a heat source they are very attractive with either a gas turbine or a combination steam and turbine plant. They have worked well where used.

Higher temperatures and pressures for industrial plants have followed the same upward trend as in utility plants. Furthermore, in the average industrial plant, the power requirement is increasing faster than the process steam requirement, a development which favors the installation of generating capacity with process steam as a by-product. As power requirements rise, the extraction condensing turbine begins to take precedence over the older type of non-condensing unit.

Selection of initial steam conditions is not restricted by a process condition, as is the extraction or exhaust pressure, and therefore, the highest practical steam conditions should be used. As a further economy, feedwater heating can reduce the fuel chargeable to net power as much as 30 per cent. Consideration of the above factors will show that industrial plants which use steam would profit significantly by producing by-product power, and that at the most efficient conditions.

In the simplest condition, a plant which requires 350,000 lb per hr of 50-psig steam can have either of the following installations, using the same amount of fuel and having the same size boiler: 1. a 50-psig boiler, a requirement for 25,000 kw of purchased power, and 350,000 lb per hr of steam; 2. a 1250-psig, 900-F boiler turbine generator unit producing 25,000 kw of electricity, and 350,000 lb per hr of extracted steam. In most cases, the savings in the cost of electric power would pay for the cost of the generating plant in a reasonable time.

This philosophy can be extended to applications such as large heating systems which up to now have been restricted to steam, or more recently, high temperature hot water. In a great many cases, especially if a large distribution system is involved, an electric system, including radiant heaters, will cost less than a conventional system with distribution piping, controls, radiators, traps, pumps, and all the associated paraphernalia.

Savings Possible

The generating system, as a matter of fact, will probably be paid for in the savings on the maintenance alone. A bonus at no cost could be realized by the fact that electric heating can be controlled and measured at each individual apartment, thus doing away with the expensive problem of open windows and would eliminate complaints of "too little heat." Of course, in some instances, the power can be purchased more cheaply than it can be generated. The point to be observed is that the high cost of labor, in installation and maintenance, will more and more dictate the choice of equipment which in the past would have been considered too expensive.

Cycle conditions under which the process operates, define the design economics of the plant. In addition

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New Power Plant Be Really Modern?

Your plant may be new, but are you getting the benefits of advanced techniques and new developments? Now is the time to review your plans with a critical eye. You can hardly afford not to, since cost of labor and fuel are expected to increase indefinitely

to selecting design conditions which will economically serve requirements several years hence, advantage should be taken of the future savings possible by considering the layout in view of today's and tomorrow's requirements. Manpower will be a key expenditure, so reduction of manpower needs is a must. The ultimate is a completely automatic system, but the most economical will probably be an installation using only a few people.

Plant Layout

There are other requirements which should be fulfilled:

1. Safe operation should not be left to the skill or discretion of the operating staff.

2. Functions of the plant which are concerned with economical operation should be adjusted to the optimum conditions by the control system. Any adjustments which can be made by the operator should be possible only within the limits of safety and economy.

3. Plant layout should be such that only the minimum personnel will be needed; also, that highly trained personnel be mandatory only at key points. As a corollary, it has been axiomatic in the past that the fewer people needed the higher would be their grade. This need no longer hold true. Design the systems to operate and be maintained easily.

4. Economy of space as well as initial cost must be considered. This is another reason, certainly, for using the advanced process conditions.

In planning, cost and space needs of an item should be related to the type of service expected. For example, a conventional large 50-kw emergency diesel or gasoline generator can be replaced by a quick-starting, high-speed gas turbine generator half as big. Even assuming greater first cost for the alternative equipment, savings can be anticipated on the basis of reduced space requirements.

Here are some other questions to be applied to a prospective layout:

Are personnel functions centralized?

Are maintenance and operation convenient?

Will the operating crew have the maximum benefits of good lighting, attractive surroundings, easy communication, convenient maintenance?

Is the entire layout "understandable," or is it apt to be cluttered and confusing?

Do the plans provide that, at no extra present cost, future additions can be made with a minimum of schedule disruptions and at least cost? Figure 1 is a prospective plant layout illustrating this point. Note the advantages which good layout emphasizes:

(a) Steam piping and heavy electrical wiring are at a minimum. (b) The operating level is spacious and uncluttered. (c) The control room is so placed that the operators are together and yet each operator can see his particular section of the plant. (d) Operating floor supports none of the heavy auxiliary machinery, so that floor structure requirements can be kept down. (e) Future addition to the plant will utilize the same control room, shop, gantry crane, and coal conveyor system, each of which will still retain its advantages. Initial plant investment is not increased by these provisions for expansion. (f) Gantry crane and shop are so placed that weight handling from operating floor to ground floor, and from flat car to shop area, is easy.

Long-Range Economy

Prospective layout may be studied by means of an industrial model. Although a complex model is expensive, much time can be saved in subsequent layout work by its use. Arrangement of the components can be reviewed and rearranged as desired, prior to actual building, without expensive engineering re-drafting.

Control panels can be mocked-up by your own people. Request one-quarter size pictures of the instruments and controls from the manufacturer, and make up a one-quarter size panel, which can be arranged as desired for most convenient and easiest operation.

There are other design techniques available which will achieve better design. They will save in first cost, and in all cases provide long-range economy. For instance:

Feedwater regulator on a boiler is an expensive investment, which consumes unnecessary power and requires maintenance. It can be eliminated by using variable speed boiler feed pumps, which are driven either by a turbine or from a constant speed motor through a speed variator. While it is true that the variable speed changer may cost as much as the regulator, here are its advantages:

1. Elimination of large pressure drops through the control valve; 2. large savings in pumping costs, since the pump output pressure is only that required to provide the flow — no throttling is needed (5-hp saving in a 24-hour pump at 2 cents per kwh will save $700 a year, or enough to pay for some of the equipment); 3. saving of wear and tear on the pump; 4. selection of smaller piping, since for maximum flow the pump can be speeded up enough to overcome pressure drop, and yet will operate economically at lower flows.

All possible objections to the elimination of a feedwater regulator can be answered, except that it must be used if one pump serves two systems.

Variable Speed Drives

The above arguments illustrate equally well the desirability of applying variable speed or modulating drives to most pump applications. Eliminating throttling and start-stop operation assures economical and low maintenance operation for the life of the unit. It is possible to provide for a variable speed modulating-type pump drive at less cost than is required for a standard on-off or throttling type of drive and control.

It is pertinent to note here that two 10-gpm constant speed centrifugal pumps operated in parallel will not deliver 20 gpm. The delivery might be more in the order of 15 gpm, operation being in a lower efficiency range. Choose the pumps so that their efficiency is best at the most probable operating condition.

Modern variable speed drives, applicable not only to pumps but to blowers, coal feeders and other systems in a plant, are either hydraulic, electromagnetic or mechanical. The hydraulic unit is generally similar to a conventional hydraulic coupling, but it incorporates a device for varying the amount of fluid in the coupling. A somewhat more expensive hydraulic drive is the torque converter.

The electromagnetic drive looks like a motor, but provision is made for varying the excitation, which governs the slip, hence the speed ratio.

Range of speed control which is

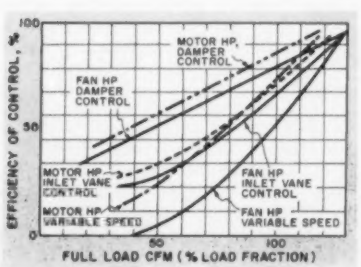


Fig. 2. Horsepower needed to drive FD fan using different methods of control

required will affect the cost of the unit selected, but this range is generally less than one might casually think. This is especially true in the case of a centrifugal pump drive, where a small speed change will make a big change in the delivery.

For application where a speed control less precise than that provided by the hydraulic or electrical units is acceptable, a variable speed belt drive should be considered. These are very inexpensive, simple and easily maintained. Cost-wise, an electric motor with a built-in speed changing belt drive may cost ten times as much as a similar unit with a separate external variable speed belt device.

A belt drive has the additional advantage that selections of driven equipment can generally be made more confidently, since if the performance falls a bit short of expectation, a change in the pulley sizes will compensate and bring the system up to requirements. The motor is generally big enough so this can be done (within limits) without changing the motor.

Figure 2 is a curve showing the power savings of a variable speed drive applied to a blower. Large power economies are possible, depending on the blower efficiency.

An important feature is included in most variable speed drives (which can also be incorporated by the use of an on-off coupling or a clutch in the drive). This is the reduction in starting and electrical equipment requirements if the motor can be started without load. The motor can be cheaper, as well as the starting equipment. Less provision needs to be made for overload starting currents.

Once you have arranged for no-load starting, across-the-line starters may be used. One company makes a line of large squirrel cage motors which can be started in this way. Starting torque is 60 per cent of normal, as against the NEMA standard 120 per cent, but starting current is only 420 per cent, considerably less than the 550 per cent used by the standard NEMA motors.

How About Flexible Couplings?

When you plan for a plant which will be trouble-free for its whole life, why not consider the use of flexible-type couplings instead of rigid flanges or gear-type units? In theory, all new machinery is correctly aligned, but aging, temperature variations and pipe stresses may disturb the original perfection. Each time the machine is taken apart, the alignment suffers. Flexible couplings are the simple answer to many of the maintenance problems that are caused by such faulty alignment.

To be completely effective, however, a double coupling should be used so that some lateral displacement, as well as angular misalignment, may be tolerated.

Some of the flexible couplings can be easily fitted with torque limiting or indicating devices which provide a simple way of preventing and controlling overloads.

Now is the time to build into your pressure units some provision for the injection of some type of leak-detecting tracer, such as Freon. Leak detection then becomes a simple matter of injecting the tracer, and testing the suspect joint with a high sensitivity indicator.

Other methods can be used, of course. One utility company is using a main condenser in which all the tube mouth bells are machined flush. A thin membrane placed across the face of the tube sheet will rupture at the spot where a leak exists, due to the vacuum inside the condenser.

Speaking of Condensers . . .

It is a definite advantage to be able to reverse the direction of the cooling water flow, because: 1. small trash, silt, etc, is washed out of the tubes; 2. erosion effects are distributed to both ends of the condenser; 3. the change in temperature when inlet and outlet are reversed will kill algae and shell growth, and thus preserve the heat transfer efficiency of the unit. Flow reversing arrangement might be a group of four butterfly valves (two of which would always be installed for shut-off) or a fabricated flow diverter. Another manufacturer uses a movable elbow in a housing as a neat solution.

Can You Use Aluminum?

In any new design, take advantage of the light weight and corrosion-resistance of aluminum. Why not use an aluminum unit? You will get less corrosion, so less fouling and corrosion allowance is required; furthermore, heat transfer is somewhat better. Building costs will be about the same as for steel, but shipping and handling charges will be less. If the condenser is elevated, structural requirements are reduced.

Aluminum is somewhat more susceptible to pH of the water, but this is not a difficult problem to control. The same material considerations can be applied to low temperature low pressure heat exchanges. To get the full benefit of possible cost savings, however, find a manufacturer who has had experience with such material.

Aluminum can be used profitably for boiler casings and pipe jackets, where its higher first cost is offset by reduced painting and maintenance needs. As a snap-on outer insulation protector, aluminum is definitely cheaper than any type of plaster and canvas insulation protection, and has the additional advantage of remaining serviceable no matter how frequently it is removed during repairs.

Good place to look for savings is in the design of the feedwater heating system. It is now practical to put several feedwater heaters in one shell, with resultant savings in purchase and installation costs. This also gives some gain in the thermal efficiency of the plant.

Another recent advance made practical by improved materials and techniques is welding of heat exchanger tubes to the tube sheets, instead of rolling. For severe operating conditions, this provides a permanently tight joint.

Fly Ash

As air pollution becomes more of a community problem, the quantity of fly ash which may be discharged from the stack will be progressively reduced. It would be most wise to provide for precipitation and collection of this fly ash. Several uses are being developed, and in the near future fly ash may have a definite value as an ingredient for special grades of concrete.

Another approach to the problem of fly ash disposal is to reinject it into a wet bottom boiler; some of it may be refired, and some will be removed after contact with the molten slag at the furnace bottom. One new furnace handles the combustion gases in such a way that the fly ash intimately contacts the molten slag, and only a small percentage remains in the flue gases.

The boiler just mentioned is one of several new designs which cause the combustion gases to swirl around a small part of the furnace. A long burning path allows adequate combustion time, reduces the special furnace volume, and helps to keep the flue gases free of suspended matter such as ash and unburned fuel, with resultant high heat transfer and minimum fouling of tubes. Boiler efficiencies above 90 per cent have been attained.

Pressurized Boiler

The pressurized boiler, long a standby in the marine service, is now being applied to industrial uses. Advantages are smaller size, reduced air leakage, and the use of a single blower and control instead of an F.D. fan and an I.D. blower (and their controls) which are used in the balanced draft boiler. Again, reduced maintenance results.

On reason for the increased popularity of pressurized boilers is the recent development of blowers having vanes in the form of an air foil. Such fans have efficiencies as high as 92 per cent. An additional saving with this type of fan is that efficient load regulation at normal operating loads is possible with cheap inlet vane control.

The new designs are capable of a pressure of over 93 in. of water, or about 3 psi. These capabilities might qualify these blowers for some new uses, such as compressors for pneumatic conveyors systems where large amounts of low pressure air are required. THE END

Editor's Note: **The author will continue this discussion in a later issue.**

Power Engineers' Valve Manual . . . .

This fourth article in a basic valve series covers Globe Valves, and gives all pertinent information pertaining to them. Written by an authority in the field, this article will later be reprinted in a complete Valve Manual for our readers. It is a power library essential

GLOBE VALVES

BY GEORGE W. HAUCK

Manager

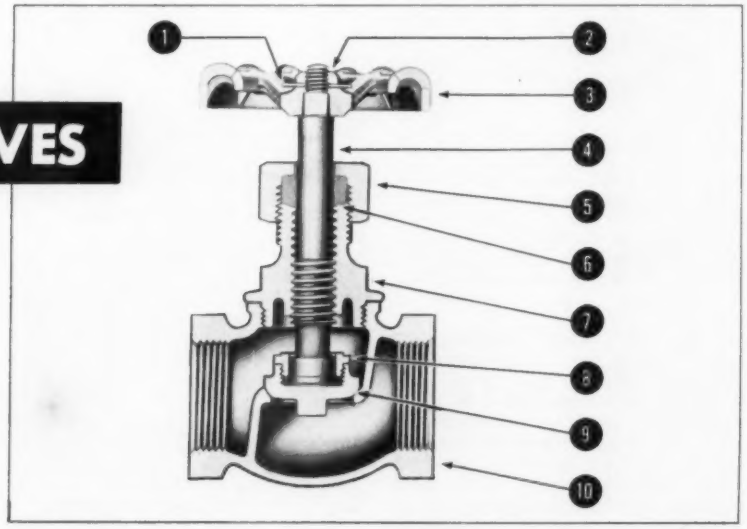
Engineering Sales

Crane Company

Born and educated in Cincinnati, Ohio, George Hauck entered the employ of Crane Co in 1913. He was a sales engineer in the local office until 1935. Later that year, he spent seven months in Chicago, collaborating on a new company catalog. Returning to Cincinnati, he spent 1½ years as consultant in engineering, and covered some 15 branches in six states.

Since 1937, Mr. Hauck has been located in Crane's Chicago home office, serving in several capacities. Since 1940, he has been Manager of Engineering Sales, supervising home office activities in the fields of power plants, atomic energy and fabricated piping.

Mr. Hauck's 45 years of experience is drawn upon in this article; he has also contributed many articles to technical journals in the field.



Nomenclature of component parts, in the valve shown above, applies to most globe valves. 1. Identification plate; 2. Wheel nut; 3. Wheel; 4. Stem; 5. Packing nut; 6. Packing; 7. Bonnet; 8. Disk stem ring; 9. Disk; 10. Body

GLOBE VALVES have been around for a long time, being one of the earliest types of valves. They have been used consistently in those services for which globe valves are ideally suited. The only changes over the years have been evolutions in materials and designs that have kept pace with changing conditions of service.

For a better understanding of the functions of globe valves it is necessary to highlight one essential difference between globe and gate valves.

Gate valves are designed to completely open the line to flow, or to completely stop the flow. They are therefore, used wide open or fully closed, and are not intended for throttling service.

As opposed to a gate valve, a globe valve provides an additional function — it can be used wide open, fully closed, or with the disk in an intermediate position for regulating the flow. The character of the fluid and the degree of control desired determine the particular design of globe valve that should be used.

The predominant usage of globe valves is found in the three, appreciably different, basic types as shown above (ball-type disk), Fig. 1 (composition disk), and Fig. 2 (plug type disk). There are some modifications and variations of these disk and seat constructions, but they do not affect the fundamental differences or the recommended usages of the three basic types.

Ball-type disk: This is the earliest type of disk and seat construction for globe valves. A ball-shaped disk seats against a tapered, flat-surfaced seat in the body. This type is economical in price, and popular for relatively low-pressure services that are not too demanding in scope. Such a valve preferably should be used wide open or fully shut, but it also can be used for moderate throttling of flow.

Composition disk: The composition disk is an improvement over the ball-type disk for many services. The renewable disks are made from compositions that are varied for specific services, such as cold water, hot water, petroleum products, steam and air. The soft composition disk makes this type of valve ideally suited for compressed air and gas services.

Small particles of foreign matter which would damage a ball-type disk seating upon closure are not likely to damage a composition disk valve

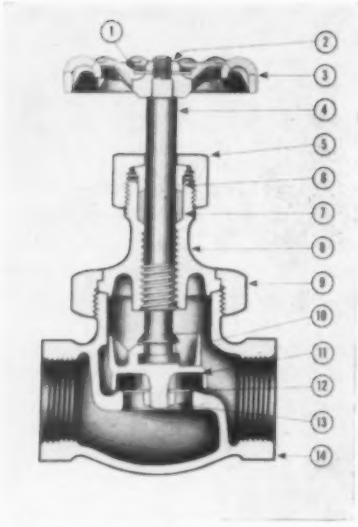


Fig. 1. One basic type of globe valve. Composition disk is shown as Item 12

1. Name plate; 2. Wheel nut; 3. Wheel; 4. Stem; 5. Packing nut; 6. Gland; 7. Packing; 8. Bonnet; 9. Union bonnet ring; 10. Holder; 11. Disk; 12. Washer; 13. Disk nut; 14. Body. (Most common type of globe valve for low-pressure)

because the foreign particles will imbed themselves in the relatively soft disk.

In addition, this valve is easily repairable, which is desirable in valves that are subjected to hard service through frequent operation. The simple replacement of the composition disk usually effects a quick repair, and restores the usefulness of the valve without removing it from the line. The slip-on disk holder and

1. Wheel; 2. Stem; 3. Packing nut; 4. Gland; 5. Packing; 6. Bonnet; 7. Union bonnet ring; 8. Disk stem ring; 9. Lock washer; 10. Disk; 11. Body seat ring; 12. Body; 13. Wheel nut; 14. Identification plate. (Note parts 10 and 11)

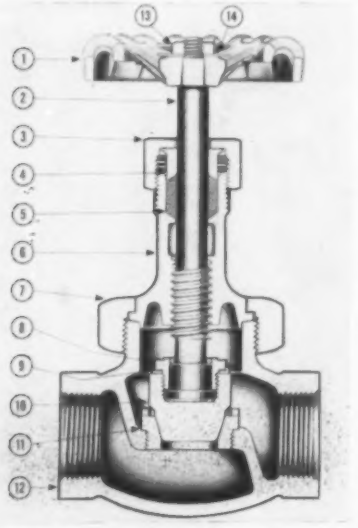


Fig. 2. Plug type disk seats into tapered seat in the third basic globe valve

union bonnet supplied in better quality valves of this type expedite such repairs.

Plug-type disk: This is the best of the three types for throttling and hard services. The renewable plug type disks and body seat rings comprise designs and materials which withstand exacting services.

The disk is a cone seating into a cone, producing a wide seating surface that is not easily affected by foreign matter or by wiredrawing in throttling services.

Needle point disk: One modification of the disk-and-seat construction, used in the three basic designs of globe valves, is found in the needle point valve, Fig. 5. The diameter of the seat opening in this valve is reduced. The stem threads are finer than usual, so that considerable turning of the stem is required to increase or decrease the opening through the seat. This type of valve is especially suitable when very close and delicate regulation of flow is desired. Needle valves have many applications in instrumentation.

Materials of Construction

Bronze valves are produced in two bronzes, ASTM Specification B 62 or ASTM Specification B 61. The lower pressure valves are made of the B 62 bronze, whereas the higher pressure valves are made of the B 61 bronze.

Iron body valves are made of two cast irons, ASTM Specification A-126, Class A for valves having light sections; and Class B for valves having medium metal thicknesses.

Steel valves, (some cast, some forged), are available in a variety of steel compositions to ASTM Specifications.

For services of a special nature, we encounter such materials as nickel-bearing irons, nickel-bearing steels, several types of stainless steels, Monel, nickel, Hastelloys, plus titanium, and other alloys.

High Pressure and Temperature

Small valves range in size from ½ in. to 2 in., inclusive, and have socket-welding ends. They are regularly made in several alloys for basic pressure ratings of 1500 psi and 2500 psi. The normal temperature limit is in the order of 1050–1060 F, but somewhat higher temperatures can be contemplated for special conditions. Likewise, valves are available on order for pressures beyond the capabilities of the 2500-lb pressure class.

Large valve designs that reflect newer concepts for high pressure and high temperature services, are found in pressure-seal bonnet valves.

Internal fluid pressure acting upon the entire underside of the bonnet reacts upon the smaller contacting area of the wedge-shaped ring, sealing the joint. Because of the design, the sealing pressure is always many times greater than the pressure of the fluid in the line; leakage is precluded.

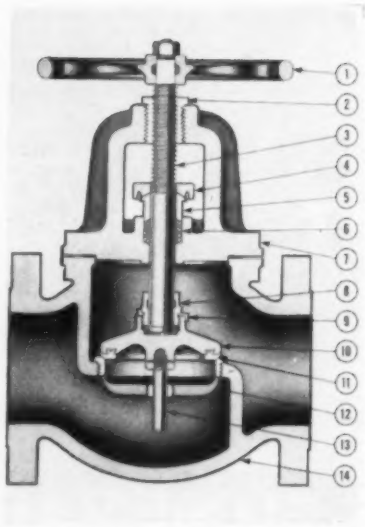


Fig. 3. This illustration shows renewable disk and seat type; Parts 11 and 12

1. Wheel; 2. Yoke bushing; 3. Stem; 4. Gland flange; 5. Gland; 6. Packing; 7. Bonnet; 8. Disk stem ring; 9. Lock washer; 10. Disk; 11. Disk face; 12. Body seat ring; 13. Disk guide stem; 14. Body. (Steel body for higher pressures)

The higher the internal pressure, the greater is the sealing pressure.

Pressure-seal bonnet valves are made in carbon steel, and several alloy steels, for basic pressure ratings of 900, 1500, and 2500 psi. The normal temperature limit is 1050–1060 F, but somewhat higher temperatures may be contemplated for special conditions. Valves are available for pressures beyond the capabilities of the 2500-lb pressure class.

The normal range of sizes for pressure-seal globe valves is 1-in. to 8-in.

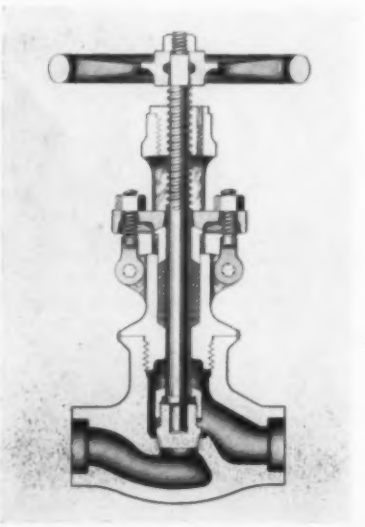


Fig. 4. Type of bolted-gland globe valve. A tight joint is easily maintained

Materials For Globe Valve Seats

The simplest form of seating is a disk of the same material as the valve, mating with a machined surface which is integral with the valve body.

Two constructions are used for composition disk valves. The composition disk may seat against an integral seat in the body, or it may seat against a seat ring. These two constructions are found in both bronze and iron valves.

In the construction of all iron valves, the all-iron disk may seat against an integral seat in the iron body, or it may seat against a renewable iron seat ring screwed into the body.

Renewable seats: Moving into the realm of superior types of valve construction, we encounter many designs with the disks and body seat rings made of materials that are different than the valve proper, whether the valve be bronze, iron, or steel. This finds valves with the seating parts made of much better materials than the parent valve metal, not necessarily for the renewability feature but for getting better wear-resisting qualities and longer life in these vital parts.

This type of renewable disk and body seat ring construction is found in bronze, iron, steel, and alloy valves.

The more commonly used renewable seating materials are several nickel alloys; a copper-base, nickel-tin alloy, and a nickel-base copper-tin alloy. Also, a chromium-iron, which is specially processed and heat-treated to develop the desired qualities. For special services, these parts are made of Monel, 18–8 stainless steels, Hastelloys, and Stellite.

Bonnet Construction

Scattered references to bonnet construction have appeared previously but not in any comparative vein. With particular reference to bronze and iron valves, attention should be focused on three types of construction used to connect the body and the bonnet of globe valves.

Screwed bonnet: This is the earliest type and the simplest form of bonnet-body joint; see first drawing. It is sturdy and practical but obviously presents some limitations in dismantling and reassembling. Its use is generally restricted to the lower pressure bronze valves.

Union bonnet: The union bonnet (Figs. 1 and 2) provides a strong, tight joint, yet it can be easily dismantled and reassembled without danger of injury to the valve. The union ring reinforces the bonnet joint, and when the valve is being reground, it centers and guides the valve trimmings, thus simplifying this maintenance operation. Withal, the union bonnet accomplishes its tasks in a minimum of space.

Union bonnet construction is applied to bronze and iron valves in sizes 2 in. and smaller. Sizes 2½ in. and larger have bolted bonnets.

Bolted bonnet: The bolted bonnet more or less takes over where the union bonnet stops. It is used on bronze and iron valves in the 2½-in. and 3-in. sizes and on all sizes of large bronze or iron valves (Fig. 7).

The bolted bonnet assures liberal strength and makes a tight joint. It can be dismantled and reassembled readily and repeatedly without damage to the valve.

Small steel valves: Conventional small steel valves (except bar stock) are equipped with union bonnets or bolted bonnets. However, the application of union bonnets is more limited with respect to the range of sizes so equipped.

The 600-lb steel globe valves are fitted with union bonnets in sizes ¾ in. and smaller, whereas most bolted bonnet valves on the market are available in ½-in. to 2-in. sizes. The 1500-lb steel globe valves have bolted bonnets on all sizes from ½-in. to 2-in., inclusive.

Means for Operation

Users can avail themselves of a variety of means for operating globe valves. The conventional means of operation utilizes a hand wheel. Chain wheels can be applied for convenience in operating valves located above a normal reach from the floor or operating levels. Extension stems, with or without floor stands, perform a similar function.

Hammer-blow wheels provide the additional power usually needed for the first effort of unseating and to effect tight closure, in larger steel valves.

Globe valves are available either with or without gearing. The size and pressure class have an important bearing on whether or not gearing is necessary. (See Fig. 7.)

Gearing is recommended in the 300-lb class for 8-in. and large globe valves; in 600-lb for 5-in. and larger; in 900-lb for 4-in. and larger; in 1500-lb for 3-in. and larger sizes, when they are used for differential pressures in the upper range of their service ratings.

Motor operation of globe valves finds a wide range of application in piping systems. Its use provides safety in emergencies, saves labor, expedites operation of valves in inaccessible or distant locations, makes possible extreme flexibility in the operation of piping systems. Control of operations can be from one or several stations.

Atomic Energy Valves

Valves for atomic energy services are predominantly produced at present in Type 304 stainless steel. It is necessary to achieve a much better than normal interior finish and maintenance of cleanliness also is very important.

The bulk of production is in valves that are hermetically sealed against outward leakage of radioactive fluids.

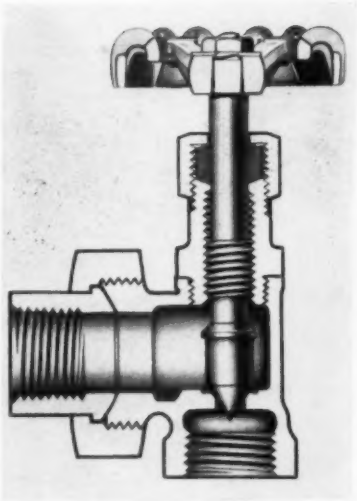


Fig. 5. Needle-point disk globe valve; for accurate throttling applications

At all stages of production, these valves and their components are subjected to a series of very exacting nondestructive tests (See Fig. 6.)

Throttling Services

Globe valves are installed frequently in services where the sole function is to regulate the volume of flow by throttling. A typical example is the valve in the bypass around a pressure regulator or other type of automatic device.

Care should be exercised in sizing such bypass valves; proper sizing is the key to maximum life and better

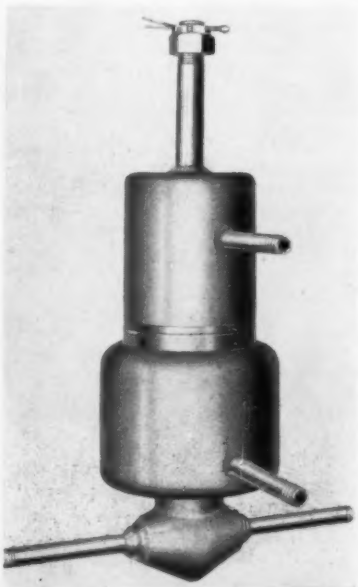


Fig. 6. One type of hermetically-sealed globe valve, made for atomic plant use

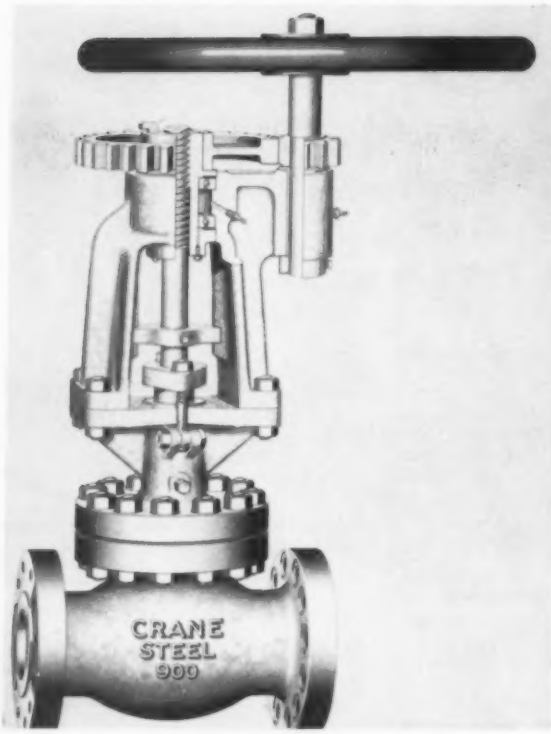


Fig. 7. Gear-operated globe valve. Recommended for 8 in. and larger, in 300 lb. class; also 3 in. and up, in 1500 lb

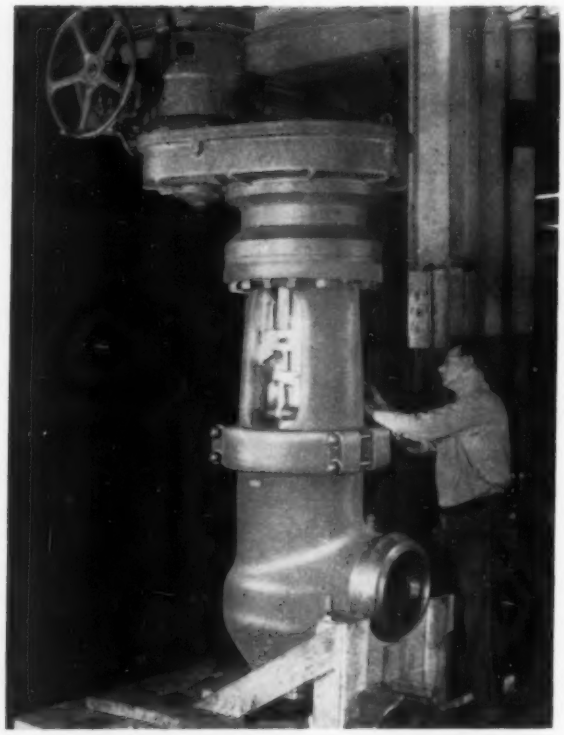


Fig. 8. Large size motor-operated globe valve. Note motor and gear housing on top. Hand wheel provides manual operation

control of flow. If the bypass valve is too large, the disk will only be cracked off its seat for sufficient flow. Under this condition of close throttling, there obviously will be increased velocity and more wear in the form of wire-drawing of the disk and seat. Conversely, a smaller sized valve will pass the same flow but with the disk farther off its seat in a wider open position, resulting in less wear, better regulation of flow, and a minimum tendency to vibrate.

In larger, higher-pressure globe valves used in the bypass line around boiler feed-water regulators, it is good practice to design the seat opening in the bypass valve for the conditions of flow. Thus it is not unusual to find a 6-in. valve with a reduced parabolic disc in the order of 2½ or 3-in. seat size.

Occasionally, in throttling service, the demand calls for such a wide variation in flow that it is inadvisable to expect one valve to do the job and not suffer from abnormal wear and maintenance shutdowns. The combination of two valves not only reduces wear appreciably but permits closer regulation of flow.

Maintenance Tips

Dirt: The greatest enemy of valves is foreign matter — dirt, scale, chips, weld spatter, and the like. Most troubles with valves are attributable to foreign matter.

Every effort should be made to thoroughly clean out piping before it is placed in service. It will prevent a lot of subsequent maintenance on valves. There is justification also for the installation of strainers in strategic locations. A small investment in a strainer can pay big dividends in protection against the costly ravages of foreign matter.

Closing valves: Never put a wrench on the wheel, or apply any form of leverage; it won't help anything, and you may break the stem or the wheel.

If a globe valve starts to leak, brute force will not make it tight. Instead, bring the disk to its seat gently, back it off a turn, and repeat this operation several times. If a piece of foreign matter has lodged on the seat, this action may flush it away. If this fails, take the valve apart and clean it. If the seating surface is cut, you can refinish or replace these parts.

When a globe valve has been closed while it is hot, it is good practice to follow up later with an extra nudge on the wheel to assure final tight closure. This is particularly advisable when a valve is subjected to temperature and has pressure under the disk. After such a valve is closed, the upper parts (stem, etc) cool and contract slightly, thus reducing the thrust on the disk. A following application of additional compensating thrust is the answer for this situation. A slight extra pull on the handle does the trick.

Leakage: Usually caused by:

a. Damage to seating surfaces by foreign matter
b. Wire-drawing of seating surfaces due to throttling
c. Normal wear in seating due to usage
d. Normal wear in stuffing box packing and/or stem
e. Bonnet joint leakage

Small leaks become bigger leaks unless repaired promptly. It is equally axiomatic that a valve is no better than its seat.

Conclusion

Globes and angles comprise quite a family of valves, as evidenced by the range of sizes, pressure classes, materials, and connections, types of disks and seats, and other varied details of construction. Users, therefore, can avail themselves of considerable latitude in selections.

The benefits available in great latitude of choice require a degree of forethought in evaluating what a valve is expected to do, how it is to do it, what degree of repairability is wanted, what economies are involved in considering first cost as opposed to final cost. When needed, the background of experience acquired by manufacturers should be used.

Haphazard selections usually produce unwarranted trouble in operation and headaches for maintenance crews. Wise choices produce adequate life and good service. THE END

Use Your Turbine Governors To Cut Operating Costs

By W. B. WILSON* and G. H. GIBB†

BECAUSE OF their ability to generate low-cost by-product kilowatts and supply process steam at the different pressures required, steam turbine generators are the workhorses of the process industries. Seventy-five per cent or more of the electric power required in some process plants, such as an integrated pulp and paper mill, or a chemical or steel plant, can be generated with modern turbine generators as economical by-product power.

This article should suggest ways that additional governing arrangements can be used to reduce the operating costs in your plant. Few process-type turbine generators have the same application requirements. Even so, manufacturers have been able to furnish simple, reliable governing systems to control the normal variables desired, and automatically transfer functions as required during abnormal or emergency operating conditions.

Some of the variables that can be controlled by the main turbine generators in industrial power plants include:

1. Frequency
2. Load
3. Purchased power
4. Pressure in as many as four steam systems
5. Pressure on waste-fuel boilers
6. Condenser flow
7. Inlet flow
8. Flow in or out of any automatic-extraction-admission opening

Above variables and various combinations of them are controlled by turbine governing systems utilizing three basic governing components. These components are the speed governor, the pressure governor, and the position-restored relay.

Almost 100 per cent of the turbine generators being installed in industrial power plants are of the automatic-extraction, or straight non-condensing type. These may be single, double, or triple automatic-extraction units.

Perhaps 75 per cent or more of these extraction turbines are automatic-extraction condensing, and the remaining units are automatic-extraction non-condensing, such as the single automatic-extraction non-condensing unit shown in Fig. 1.

Universal acceptance of these units is largely due to the simplicity and reliability of governing systems which have been developed to automatically control many of the variables that affect over-all industrial plant operating costs.

Conventional Arrangement

Even with the conventional arrangement of the standard components, today's operators have considerable choice in selecting an operating procedure. For instance, these arrangements permit:

1. Using the turbine to share load changes with other turbines. Turbines of equal ratings with equal regulation will share load changes equally.
2. Setting a base load on the turbine by operating in parallel with a large system or in parallel with another turbine which has a speed compensator in service.
3. Using the turbine to hold constant frequency and to absorb load changes by using the speed compensator.
4. Adjusting regulation on pressure governors to share changes in steam flows with any other pressure controllers that it is desired to operate in parallel with the turbine — that is, other turbines, boilers, or pressure reducing valves.

Auxiliary Devices

For all the above conditions, the extraction mechanisms can be in service to hold process-header pressure, or can be set for a constant amount of extraction or admission flow from any one or all of the automatic-extraction and/or admission openings.

Number of possible operating procedures can be increased to meet most any application requirement by the addition of other devices such as:

1. Exhaust pressure
2. Initial pressure
3. Load limit
4. Constant condenser flow
5. Speed reset and transfer

Economics is always a factor in deciding what is required, but even the seemingly-complex problems can often be handled very simply with modern turbine governing systems. Sometimes characteristics or features of the turbine governing system can be utilized to simplify operating problems that are seemingly unrelated to turbine governing. By knowing more about the control functions needed to simplify process plant operations, the application engineer and the governor designer can often devise an economic method of doing the job.

Typical Conditions

This example includes several devices on one single automatic-extraction condensing turbine. Solution of the control problems associated with this application requires a governing system which 1, normally operates to generate maximum by-product kilowatts and control extraction pressure with additional electrical-power requirements purchased from the utility with which it is operating in parallel; 2, is ready to generate condensing kilowatts to limit tie-line load; 3, can trip to speed and extraction-pressure control in case utility tie is lost; 4, sacrifices extraction-steam flow to generate kilowatts when adequate boiler steam is not available, and 5, has initial-pressure governor to close high-pressure valves and decrease kilowatt generation if steam supply is still inadequate.

To meet these special-application requirements, the governing system

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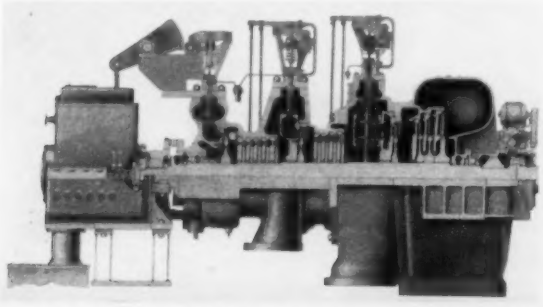

Fig. 1. A double automatic-extraction condensing turbine

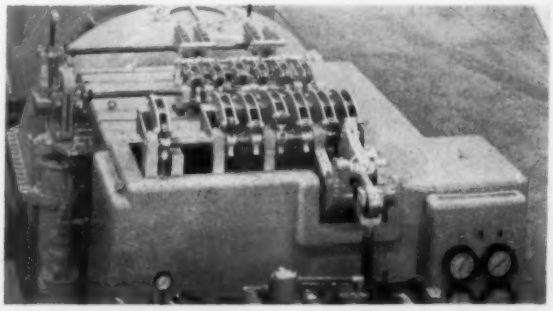

Fig. 2. Photograph of governor mechanism of turbine at left

can be arranged to accomplish the required functions automatically and in sequence as operating conditions change or as emergencies arise.

For a typical range of operating conditions, the turbine governing system would go through the following sequence:

1. **Normal operation—constant condenser flow.** Operating in parallel with the utility and with the constant condenser flow device in service, the turbine will maintain extraction pressure while satisfying fluctuating process steam demands by varying turbine inlet flow. Kilowatts generated will vary according to process steam demands. Flow to the condenser will be held at a constant minimum value. This operating procedure prevents the generation of higher-fuel-cost condensing kilowatts but permits maximum by-product kilowatts.

2. **Tie-line load control.** Since generated kilowatts depend on process-steam demand, either a decrease in process demand or an increase in plant power requirements will result in an increase in purchased power. To prevent establishing a new demand, a tie-line load controller automatically takes over control of kilowatts generated without interfering with the extraction governor's control of pressure in the process header. The additional kilowatts are generated by permitting steam flow to the condenser to supplement by-product generation from the process steam.

Whenever the process steam demand again increases, and/or the tie-line load drops below the established limits, then the tie-line load control mechanism automatically returns the turbine control system to the constant minimum-condenser-flow operation.

3. **Transfer from tie-line operation to speed governor operation.** Since the turbine in this example normally operates in parallel with a power system, it may be desirable to transfer back to speed-governor control if the tie with the system is lost for any reason. This function is provided automatically by a transfer and speed-reset device. This device acts to keep the turbine generator available to continue to provide kilowatts and process steam to the industrial-plant system after loss of the utility tie. It can be arranged to trip the governor to speed and extraction-pressure control during this emergency operating condition.

If the amount of purchased power is high at the time the tie is lost, it may be necessary to quickly dump some of the least essential loads to prevent overloading the generators left connected to the plant's electrical system. This permits local generation to carry the most essential loads.

4. **Initial pressure control.** When the unit has tripped back to speed control after loss of the utility tie, it may be heavily overloaded. The heavy electrical load, in addition to the process steam demand, may overload the boiler.

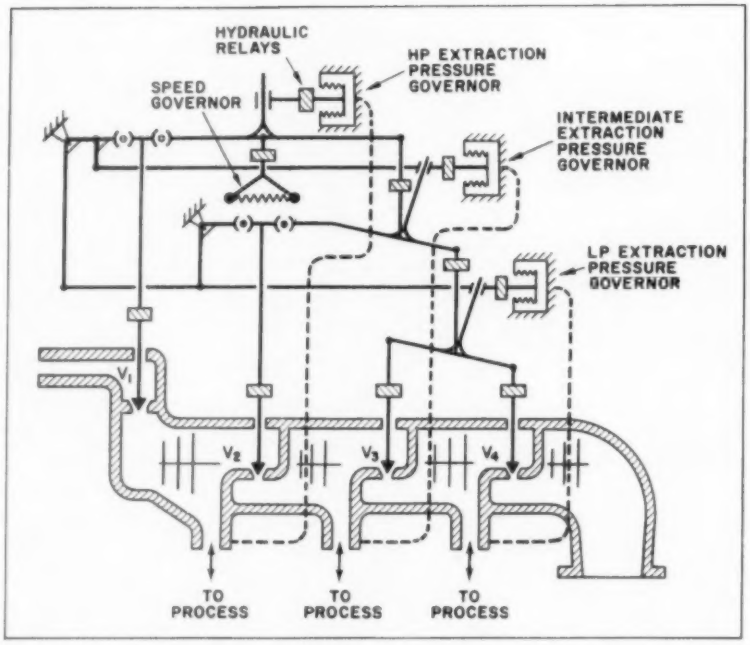

Fig. 3. Basic governing units for triple automatic-extraction condensing turbine

1. Speed governor satisfies load demands by moving V_1, V_2, V_3 and V_4 to pass the same change in flow in lb per hr. 2. HP extraction-pressure governor satisfies demands by moving V_2, V_3 and V_4 in opposite direction to V_1 at rate to maintain substantially constant kw input. 3. IP governor moves V_1 and V_2 in opposite direction to V_3 and V_4 to maintain constant kw input. 4. LP governor satisfies LP extraction demands by moving V_1, V_2 and V_3 opposite V_4

In this event, an initial pressure governor automatically comes into service to 1, reduce the extraction flow and increase condenser flow until all steam is going to the condenser; and 2, when kilowatt load reached 80 per cent of the turbine rating, to close a valve in the extraction steam line to force all steam flow from the boiler straight through the turbine even above the 80 per cent load point where pressure at the automatic-extraction point will exceed the normal pressure of the process header.

If the kilowatt load decreases sufficiently, the action described above will be reversed automatically. As the load decreases, the valve in the extraction line will reopen to restore extraction steam flow.

As a last resort, following the condition of all steam flowing straight through the turbine to make maximum kilowatts, the initial pressure governor will reduce kilowatt generation by closing turbine inlet valves as necessary to prevent loss of boiler pressure.

Manual controls are also provided

Comparative economics, capacity used as tie-line control or continuous generation

Case I

For tie-line control operation:

Annual saving in demand charge 3000 kw × $1.50 × 12 mo	= $ 54,000
Annual saving in energy charge = 1000 kw × 7 mills × 8000 hr	= 56,000
	$110,000
Annual fuel = 8000 hr × 1000 kw × 11,000 Btu per kwh × 30¢ per million Btu	= $ 26,000
Annual gross saving by use of tie-line control	$ 84 000

Case II

For continuous generation utilizing turbine capability assigned to tie-line control in Case I:

Annual saving in demand charge = 3000 kw × $1.50 × 12 mo	= $ 54,000
Annual saving in energy charge = 3000 kw × 7 mills × 8000 hr	= $168,000
	$222,000
Annual fuel = 8000 hr × 3000 kw × 11,000 Btu per kwh × 30¢ per million Btu	= $ 79,000
Annual gross saving by use of continuous generation	$143,000
Annual gross saving with continuous generation instead of operating with tie-line control = $143,000 − $84,000 =	$ 59,000

so that an operator can manually select any of the above operating procedures he desires.

Performance During Emergencies

High on the priority list of things that should be looked for in turbine governing systems is a proved ability to ride through plant and utility system disturbances, both steam and electrical, automatically doing what is necessary to minimize any interference with normal industrial plant production. During an emergency, operators have plenty to think about. If they are fully aware of what the turbine can do for them, then they can concentrate on other things that need their attention.

Different features are important in different emergencies. Sudden pickup of kilowatt load seems to be the feature that is called upon to function most frequently. Because of this, we think one of the important criteria that should always be considered is that the turbine generator is arranged to sacrifice extraction flow, or anything else required to satisfy kilowatt demand, within its capability with the flow of steam available at the moment.

In addition to having a turbine governing system that can do this, it is important that all possible emergencies be considered, to be sure that other power-plant and electrical-system equipment is arranged to fully utilize features of the turbine control system that are available, to take the necessary action in an emergency as well as in normal operation.

Another important function provided by modern governing systems is their ability to keep turbine speed below the emergency-trip speed in case full load is suddenly lost. This requires fast action, particularly with non-condensing units having low-inertia rotors. These-high speed governors keep the turbine-generator running at speed ready for resynchronizing as soon as the operator has determined that the electrical trouble has cleared.

By not having to reset the overspeed trip and open the stop valve, the turbine can be back on the line generating kilowatts at a time when seconds seem like eternity.

Tie-Line Load Control

One of the important things affecting the cost of power — either purchased or self-generated — is the per cent of time that the facilities required to meet the peak demand can be used to capacity. One of the items in the cost of purchased power is the demand charge which is related to the facilities that the utility must provide to serve the industrial load.

Demand charge will average $1.25 to $1.50 or more per month per kw or kva of demand. Demand is usually based on a 15 or 30-minute interval so the user is not normally penalized for occasional high peaks of short duration. Some users have considered it economic to assign a portion of their generating capacity to tie-line control.

As stated earlier, automatic tie-line load control or regulator equipments are available which monitor the incoming purchased power. These load regulators automatically change the industrial plant's generation.

These regulators normally look at instantaneous tie-line load and have no means of integrating the purchased power over an interval such as used for utility billing purposes. Even so, these load regulators can keep up with normal industrial load swings so that 15 or 30-min integrated demands can be controlled within reasonable limits.

High-speed load regulators, capable of changing turbine load at a rate of full load in four seconds or less, are available. Their high speed is not normally required but can be used for special applications where needed. More commonly used low-speed regulators act to change turbine load at the rate of full load in 60 sec or more. These regulators usually act through suitable relays to energize the turbine-governor synchronizing motor to change the normal-speed-governor setting in the increase or the decrease direction as required.

Standard turbine-governing systems are suitable for use with low-speed tie-line regulators to control purchased power without affecting normal performance when operating in parallel with the utility. Care must be exercised to be sure the tie-line regulator and turbine governor are arranged so that the normal turbine-governing functions will not be interfered with during emergency or abnormal operating conditions.

It may be well to remind ourselves that a tie-line kilowatt regulator acting on the industrial power plant's turbine governor can only affect kilowatts. Kilovar interchange is also a problem to be considered but, for a fixed utility supply voltage, kilovar interchange will depend on the generator voltage regulator and setting of the transformer taps on the tie.

Economics of Tie-Line Control

In evaluating the use of tie-line control, several factors must be considered to determine if it is more economical to use generating capacity for continuous base load generation instead of being used for tie-line control only.

Based on the assumed values used in the example which follows, maximum savings in annual operating costs will not result from use of a tie-line load regulator. Continuous use of the installed generating capability results in an annual saving of about $60,000 per year more than if the same industrial generator capacity is used for tie-line control only.

Many industrial power plants consider it essential to have condensing exhausts on some or all of their automatic-extraction turbine generators to give them the desired operating flexibility. In plants using tie-line control, a part of this condensing capacity is then required (must be assigned) for tie-line control.

In a very-much-simplified example, let's consider a plant using 15,625-kw turbine generators and estimate the difference in annual operating costs if:

Case I. 3000 kw of this turbine capacity is allocated to tie-line control to minimize purchased power cost.

Case II. This 3000 kw of turbine capacity is used for continuous power generation to minimize purchased power costs.

We then make the following assumptions:

1. Demand charge — $1.50 per kw. per month.
2. Energy charge — 7 mills per kwh
3. 1000 kw average generation from the 3000-kw turbine generator capacity allocated for tie-line control, that is, the integrated kwh under the jagged peaks on the industrial plant load curve are equivalent to 1000-kw continuous load.
4. Fuel charge for electric generation based on condensing performance.
5. Fuel for net condensing power generation — 11,000 Btu/kwh.
6. Fuel cost — 30¢ per million Btu.
7. The only charge allocated to the incremental generation in the industrial power plant is the fuel cost.
8. Fixed charges not included because the installed generating capacity required is the same for either Case I or Case II.
9. Industrial plant load is large enough to utilize continuous generating capacity assumed.

The comparative analyses of the two cases is shown in the table.

From this example, with these arbitrarily chosen assumptions, continuous use of the turbine-generator capability is more economical than to use it for tie-line control. This example is included here only to suggest a method of using actual data from your industrial plant to evaluate the most effective use of installed generating capacity.

Based on the data presented here, we hope that you will not be hesitant in discussing your industrial plant operating requirements with the turbine manufacturers. Even some of the ideas that seem like blue sky dreams may be easily developed into a simple workable governing system to help reduce plant operating costs.

From the examples presented here, it is evident that the power engineers and the turbine designers can devise a system that can perform almost any function which you may require to improve the efficiency of your steam and power system.

Having determined what your governing system can do, be sure that all operating personnel are thoroughly familiar with the many capabilities of the governing system so that maximum benefits can be realized during normal and emergency operating conditions. In this way, the operating advantages designed into the governing equipment can be realized throughout the life of your turbine-generator. THE END

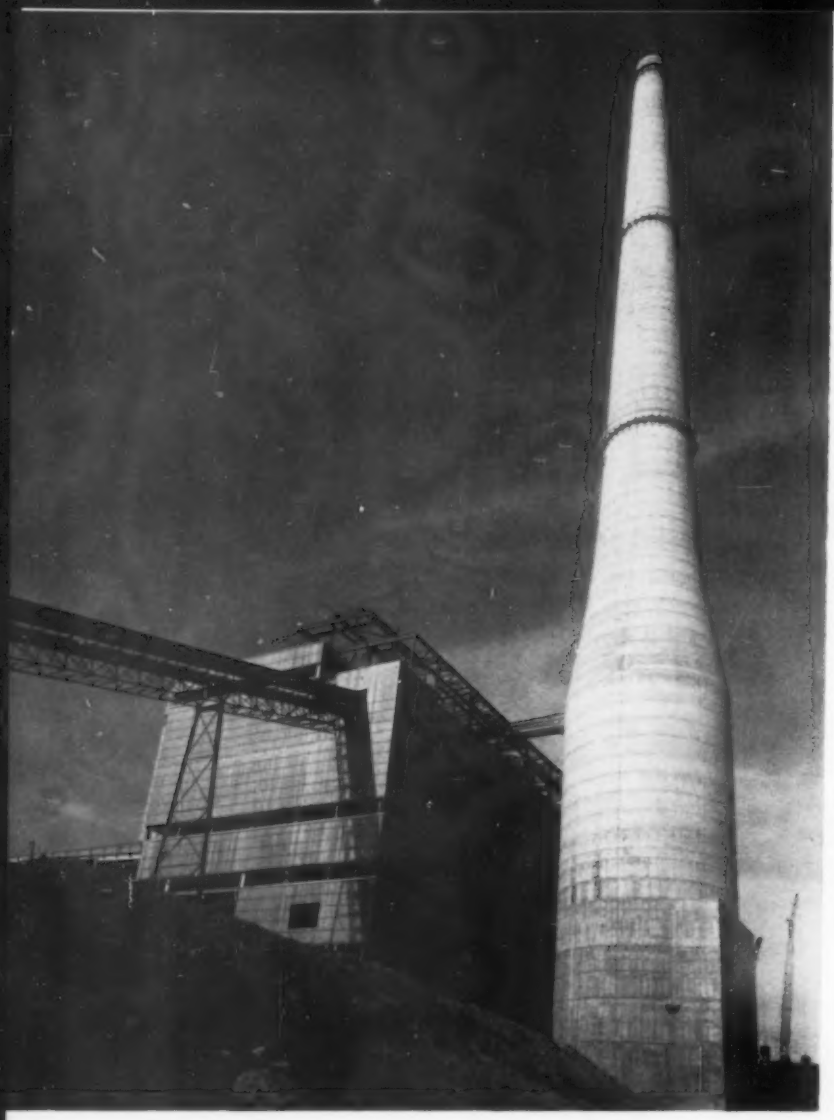

Fig. 1. Looking up at the nearly-completed top of the New Albany Power Station stack from near its base, better than 600 ft below. Unique structure is a product of engineering resourcefulness, prompted by the site conditions

New Albany Puts Stack, Crib House and Water Facilities in One Structure!

Probably no stack ever constructed has contained, within a huge foundation, so much essential power plant equipment as this one. This unique feature saved $250,000 compared to usual designs

By A. R. LeBAILLY*

NEW ALBANY Power Station of the Public Service Co of Indiana, Inc, is located on the west bank of the Ohio River adjacent to the western edge of the town of New Albany, and across from Louisville, Ky. A strip of flat land 2500 ft wide at elevation 430 ft forms the river valley, and is bordered by a hilly territory running parallel to the river. Some of these hills rise 500 ft above the valley level.

This location provides an abundant river-water supply and permits coal barging from the extensive coal fields of Kentucky and southern Indiana.

Ohio River is subject to wide level variation from a record low level of elevation 376 ft to a flood record at elevation 458 ft. A series of flood and navigation dams on the river maintain a normal pool level at elevation 383 ft.

Ultimate installation will consist of six units. The original installation consists of two 150-mw units. The next step will consist of two more units of the same size, now on order, and the last two units will probably be somewhat larger.

Combined mechanical-electrical dust collectors of the highest efficiency were provided. An extensive model study of the behavior of stack gases was made at the University of Michigan. By simulating various wind directions and velocities, this study indicated that a stack 550 ft high (top elevation 1009 ft, 6 in.) above plant grade (elevation 460 ft) would give adequate dispersal.

A single concrete stack for the first group of two units, designed for an

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*Partner, Sargent & Lundy

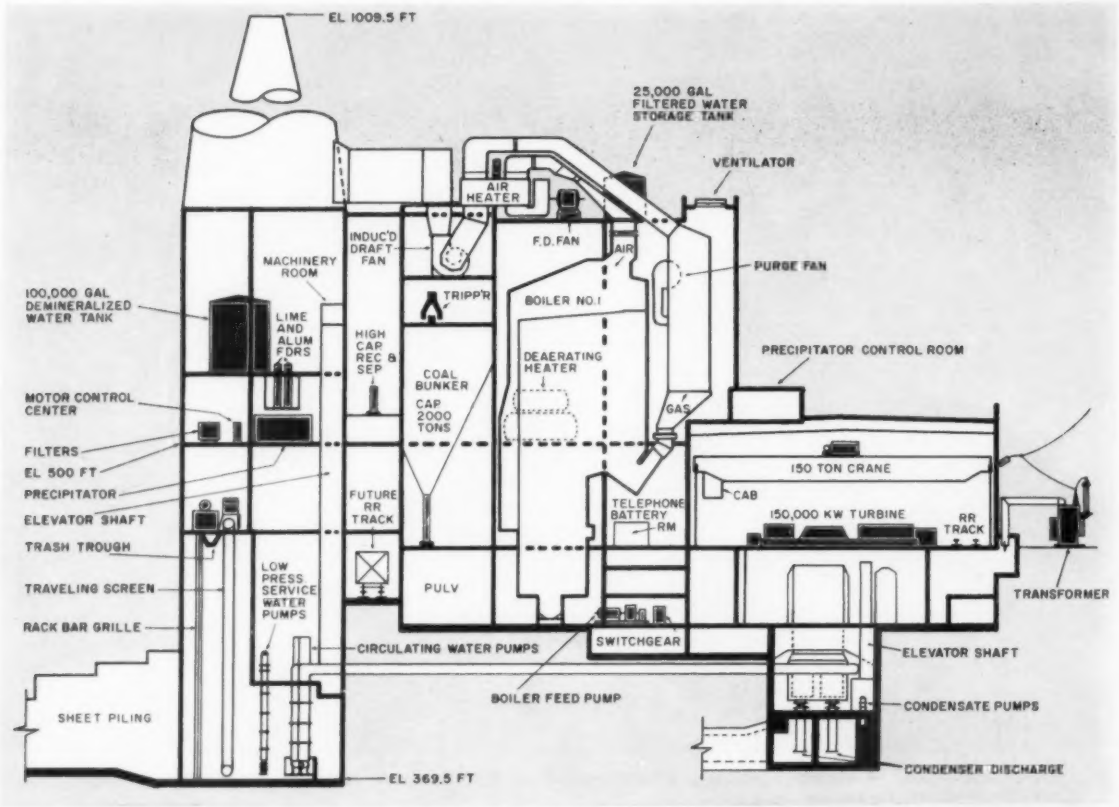
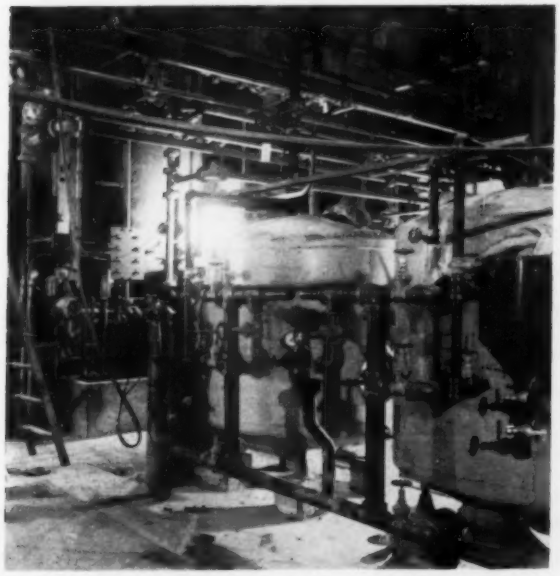
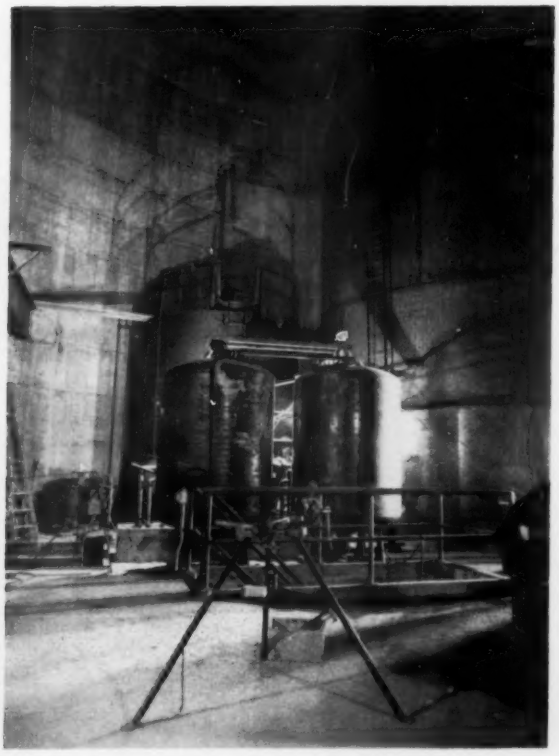


Fig. 2. Cross section of station, showing relation of integrated stack with rest of building, hinting of savings involved

Fig. 3. (Below) Part of complex included in base of stack, this scene being at elevation 500 ft. Drinking water filters are in foreground, with the demineralizing equipment beyond

Fig. 4. Photo reveals some of space available in stack bottom. Demineralizer polishing units in front, 12,000-gal caustic tank behind, one of two 100,000-gal tanks to right





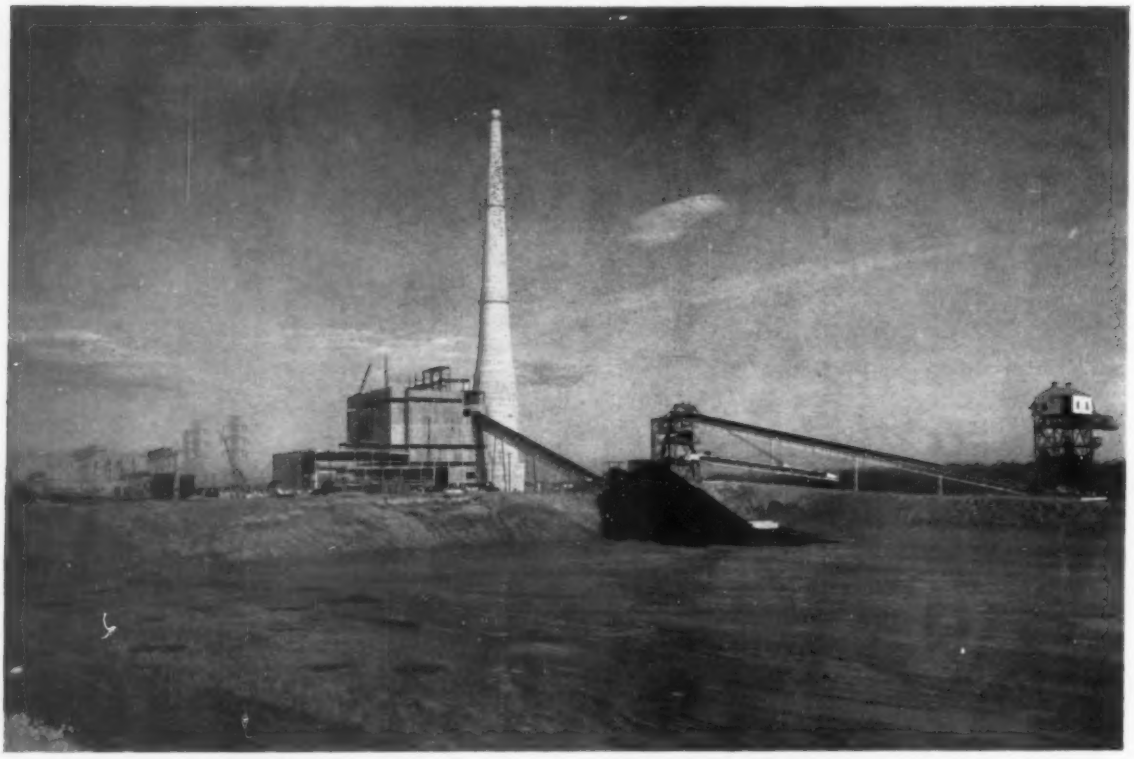


Fig. 5. General view of New Albany Station points out enormity of stack structure. Note how crane in foreground is dwarfed

exit gas flow of 1,000,000 cfm with an outlet top velocity of 120 fps, corresponding to an ID of 13 ft, 6 in., offered the best arrangement.

With the proposed switch-yard and turbine-room location, the stack had to be located on the river side. For stability reasons, the flare of the stack at grade level required 40 ft diam. An early study indicated that the stack base should be supported on foundations extending to solid rock at elevation 369 ft.

Intake crib located on the bank of the river for the first two units will supply the required 180,000 gpm of water at the minimum pool level and will also extend down to rock level at 369 ft.

It appeared logical that if both stack and intake crib had to go down to rock level that better space utilization and substantial savings would be obtained by a combined design using the stack base as the intake crib. This was accomplished by flaring the lower part of the stack to the diameter required for the intake crib.

A circular intake crib 68 ft in diam was required for four traveling screens, trash rake, log gates, four circulating pumps, four service pumps, and also an elevator.

With the proposed fan arrangement, the stack column below elevation 590 ft was available for other purposes. The traveling screens, pumps, and dismantling space do not extend above elevation 500 ft, leaving a shaft 64 ft in diam and 90 ft high, or 300,000 cu ft available for water treatment and storage, located on two floors at elevations 500 ft and 527 ft.

With a judicious arrangement, it was possible to provide freight elevator service and good accessibility for the following equipment located on these floors:

1. One 550-gpm water clarifier and accessories
2. Three 200-gpm anthracite filters
3. Four cation and anion exchangers
4. One degasifier and catchment tank and pumps
5. One acid tank and one caustic tank and pumps
6. One set of drinking water filters
7. Two lubricating-water pumps
8. One polishing demineralizer and acid and caustic tanks
9. One 12,000-gal caustic storage tank
10. Two 100,000-gal demineralized-water tanks
11. One chemical storage bin and feed hopper
12. One 55,000-cfm heating and ventilating unit

Space for the segregated location of all this equipment was not available in the plant. In addition, placing the water treatment and storage, chemicals, etc, above the traveling screens and pumps is an ideal location in many respects as it reduces the amount of piping which would have been required had the equipment been located in the plant basement. It also facilitates gravity feeds of chemicals and easy disposal of drains, filter back wash, and regeneration waste from the demineralizers.

Bulk chemical storage is accessible from the elevator with an unloading platform suitable for railroad and truck delivery outside the crib house. It is expected that concentrating all the equipment pertinent to water treatment and storage in one location will also give numerous operating advantages.

It was estimated that this combined design saved $250,000 when compared with a separate crib house and stack arrangement. THE END

WOULD YOU LIKE TEAR SHEETS?

Readers wanting tear sheets of any article appearing in the issue may obtain them by indicating the items desired on one of the return post cards appearing in this issue. (Tear sheets are separate pages originally torn out of the issue, hence the name, but now supplied to us in limited quantities by the printer.)

Sodium Test Measures Steam Purity Accurately

Throttling calorimeter and conductivity tests, once thought adequate, have given way to more accurate Sodium Test, in boiler water purity determinations. Method of conducting test is explained, and reasons are given for need of the extreme accuracy obtained by it

By **JOHN J. MAGUIRE** *

THROUGH THE YEARS, increasingly sensitive methods have been developed for the measurement of steam purity. At the same time, the concept of acceptable solids content of steam has been revised steadily downward. The conductivity method is today the most rapid and convenient method and possesses acceptable accuracy, except where corrected steam conductivity is one micromho or less. In this region, where conductivity is no longer sufficiently sensitive, the newly developed SODIUM TEST, with a possible precision of 0.04 parts per *billion*, (ppb) has proved its worth. It can be expected that increasing use will be made of the sodium test to investigate the more difficult and puzzling cases of very small amounts of boiler water carryover with steam.

Older Methods

The throttling calorimeter was the first device used for steam purity measurement. Calorimetry was applicable to determination of the moisture content of saturated steam, but was not applicable for use with superheated steam. In addition, the sensitivity of the throttling calorimeter was of low order, so that this instrument was useful only in the detection of gross moisture carryover.

Gravimetric determination of the solids content of a condensed steam sample involved the evaporation, to dryness, of a relatively large volume of condensed steam, and weighing of the solids residue. Precise technique was required — to avoid contamination by dust in the atmosphere during the long evaporation period. The method was cumbersome, and time-consuming. As a laboratory method it was not applicable to field use.

Conductivity

First major step forward in the measurement of steam purity was the application of electrical conductivity as a measure of the ionizable solids present in the condensed steam. For approximately twenty years, conductivity has been the most accurate and precise means available for measurement of the solids content of steam.

Specific conductance of a water is a measure of the ability of the water to conduct an electric current. Specific conductance is inversely proportional to electrical resistance. Pure water is highly resistant to the passage of an electric current and, therefore, possesses a low specific conductance. The theoretical specific conductance of pure water is approximately 0.04 micromhos.

If a water contains ions, the water becomes a better conductor of electricity and the specific conductance is increased. Inorganic compounds, such as sodium chloride and sodium sulfate, when in solution, dissociate into positive and negative ions, which will conduct electricity in proportion to the amount of ions present. The conductivity test, therefore, is not specific for any one ion, but rather is a measure of the total ionic concentration.

The basic unit of electrical resistance is the **ohm.** Since electrical conductivity is the reciprocal of resistance, the term 'mho' (ohm spelled backwards) was chosen as the basic unit of conductivity. In the determination of specific conductance, quite low amounts are measured and the basic unit employed is the micromho (one millionth of a mho). The conversion factor from micromhos of specific conductance, to parts per million solids, will vary dependent on the ions present and their concentration. In condensed steam concentrations, however, an average factor is 0.5 ppm solids per micromho specific conductance.

Use of conductivity for measurement of steam purity has many advantages. The determination is rapid and accurate. Conductivity lends itself to continuous recording. However, there are also disadvantages as-

*Technical Director, Betz Laboratories, Inc., Philadelphia, Penna.

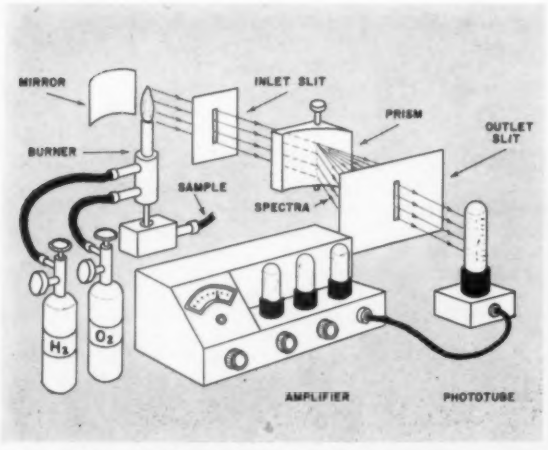


Fig. 1. Schematic diagram of principal elements in a flame photometer. Sodium flame is screened through prism into phototube, and signal is sent to amplifier for purity registration

Fig. 2. Actual purity determination of sodium in boiler water being made with conventional equipment designed for this purpose. Sodium value as low as 0.00004 ppm can be measured

sociated with conductivity measurement of steam purity. Gases present in the steam will ionize in water solution and impart conductivity to the sample. The gases that usually cause this interference are ammonia and carbon dioxide. Unless these gases are removed from the sample before conductivity measurement an erroneously high solids content of the steam will be indicated. Of course, another procedure is to determine the concentration of ammonia and carbon dioxide in the sample and then to correct the indicated conductivity for that due to the presence of these gases.

For the past twenty years, the use of conductivity in conjunction with degasification of gases, or correction for their conductivity, has served as the standard method for measurement of steam purity. However, as the purity of the steam produced from modern boilers steadily improved, and as demands increased for even purer steam, flaws became evident in the conductivity method. The standard boiler guarantee of 1 ppm solids in the steam is no longer acceptable steam purity in many cases.

With high purity steam, of conductivity in the range of 1 micromho, some plants have experienced difficulty with superheater and turbine blade deposits, while other plants have not been troubled. It is obvious that in this region of super-accuracy mere conductivity is not sufficiently sensitive to indicate the true solids content of the steam. The primary cause of this difficulty is the inability of present methods to completely remove, and to correct for the conductivity imparted by, trace quantities of ionizable gases.

Flame Spectrophotometry

Newest development, in means for measuring extremely low solids content in steam, is the use of a flame spectrophotometer to measure low concentrations of the sodium ion. Usually, the ion present in boiler water in the highest concentration is the sodium ion. With proper technique and equipment, it is possible to measure the sodium content of condensed steam with a precision of 0.00004 ppm.

Determination of the sodium content of condensed steam samples involves aspirating a portion of the sample into the burner section of the spectrophotometer. The intense heat of the flame from bottled hydrogen and oxygen evaporates the sample and causes the sodium salts, now in the form of a dry dust, to glow a bright yellow. The light from the flame is reflected by means of a mirror into the interior of the spectrophotometer, where various mirrors and prisms select the exact yellow color of the sodium flame and measure its intensity. The light of other colors is rejected. The intensity of the light is converted to concentration of sodium by comparing with the intensity given by known standards. A schematic arrangement is shown in Fig. 1.

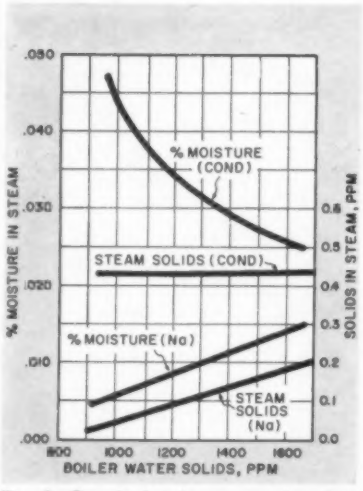


Fig. 3. Graph showing comparison between steam purity and boiler water solids; conductivity vs sodium test shown

Because sodium salts are so abundant in the atmosphere, a major problem is to remove dust from the air supplied to the flame compartment. Air filters and an electronic precipitator are employed for this purpose.

With the use of the low-sodium test, it has been possible to explain the illogical results secured in many cases where conductivity has been used as the measurement of steam purity. It certainly can be expected that, with no other variables involved, the solids content of the steam from a given boiler should increase with increase in boiler water solids. However, in many cases where the conductivity of the steam is one micromho with boiler water solids of 100 ppm, the steam conductivity remains at one micromho, when the boiler water solids are increased to 1000 ppm, and even to 2000 ppm.

Figure 3 illustrates a situation of this nature. As boiler water solids were increased from 900 ppm to 1600 ppm, the solids content of the steam, as determined by conductivity, remained at an illogically constant value slightly in excess of 0.4 ppm. In fact, the percentage moisture in the steam, as calculated from conductivity, showed a decrease with increasing boiler water solids. Test results of this nature have in the past cast doubt on the accuracy of the conductivity method, where condensed steam conductivities are one micromho or less.

Also shown in Fig. 3 are the results obtained at the same time by use of the sodium test. It can be observed that the steam solids shown by the sodium test are considerably below those indicated by conductivity. In addition, as boiler water solids increased, the solids content of the steam rose from approximately 0.040 to 0.220 ppm, a condition to be expected.

The percentage moisture in the steam, calculated from the sodium results, follows the logical trend of increasing with increasing boiler water solids.

Over the range of 900–1600 ppm boiler water solids, the moisture content of the steam, calculated from the sodium values, tripled; indicating the effect of increased boiler water solids, thereby throwing a higher moisture load on the steam-separating equipment. The solids content of the steam increased approximately seven-fold, showing the additional effect of the increased moisture and the higher boiler water solids per unit of moisture.

Conclusion

The sodium test is so sensitive that it is highly susceptible to contamination during sampling, and in the running of the test itself. Careful technique overcomes these problems. During the first stages of the test development, all test work was conducted in an isolated room in an essentially dust-free atmosphere. Improvements in air filtration and other techniques have permitted the equipment to operate successfully under plant conditions and with continuous recording of the sodium content. The continuously-recording feature adds greatly to the value of sodium steam studies. THE END

Combination Mask-Resuscitator Developed

FIRST PORTABLE air/oxygen mask and resuscitator combination unit, providing equal protection to rescuer and asphyxiation victim, has been introduced.

Known as the Dualife and weighing 39 lb, the unit contains 52 cu ft of gas in its two chromaloy cylinders, enough for about 40 minutes of use as a combination or about an hour's service individually.

Resuscitator valve and facepiece are carried in a canvas pouch on the belt strap and attached to the regulator by a quick disconnect, as is the mask valve. Built-in gages provide the wearer with accurate pressure information, and a warning bell sounds automatically when the compressed air or oxygen supply needs replenishing.

In cases of drowning, electric shock, or other forms of asphyxia not requiring a mask, the unit can be used as a resuscitator alone, and an aspirator can also be used with the unit for removal of mucous or fluid when necessary.

For more information, write the Editor, POWER ENGINEERING, or jot air/oxygen mask on the postcard in this issue.

Modern Practice in Design and Testing Of Mechanical Coal Samplers

By R. L. CORYELL* and F. J. SCHWERD†

COLLECTION and preparation of representative samples of coal, or just plain coal sampling, have received much attention over many years. Based on published information, the subject has been thoroughly discussed. However, with larger and more diverse coal shipments to new and more efficient power plants, increasing attention is being given to more accurate sampling methods with reduced labor requirements.

At the ASTM coal-sampling symposium in Chicago (in 1954), new concepts of sampling were discussed, and mechanical sampling methods were evaluated. It is our purpose here to apply much of this material, and more recent findings, to the design and testing of mechanical sampling installations. The accuracy tests described herein have been used by the writers for several years, and have been found very effective in detecting faulty sampling.

Object of coal sampling, in general terms, is to provide a small, finely-divided sample that accurately represents the large shipment from which the sample was obtained. With a heterogeneous material such as coal, accurate sampling is often difficult, since the ash content of individual particles may vary from about 3 per cent, to over 50 per cent ash.

In handling of coal, the heavier and higher ash particles are often segregated. This is particularly evident in coal cars where the ash content at the center of the car is often quite different from that at the ends of the car. Ash segregation can also occur at each stage of the sample preparation. The basic rule of sampling states that the smaller the particle size and the larger the number of sample increments, the smaller will be the ash segregation, and consequently the sampling errors.

ASTM Standard Method of Coal Sampling, D 492-48, specifies an accuracy within ±10 per cent of the ash content for commercial sampling. This means that the ash analysis of a 10 per cent ash coal must be between 9 and 11 per cent in 95 out of 100 cases. The average analysis of two or more samples will improve the accuracy unless there is a bias in the sampling operations. A bias or systematic error of over one per cent can exist in these operations, thus increasing the total error (in one direction) to as much as two per cent for a 10 per cent ash coal!

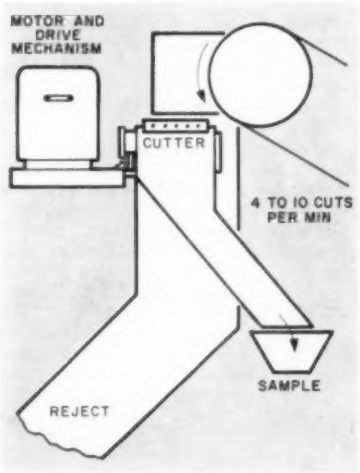


Fig. 1. A horizontally-moving sampler

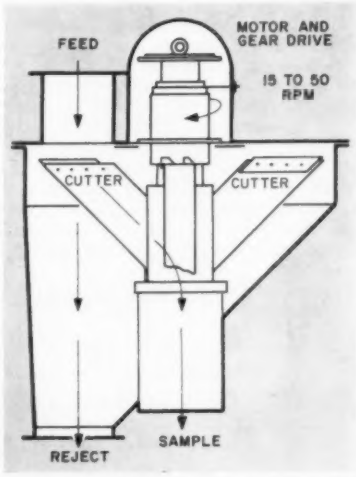


Fig. 2. Sampler with rotating cutter(s)

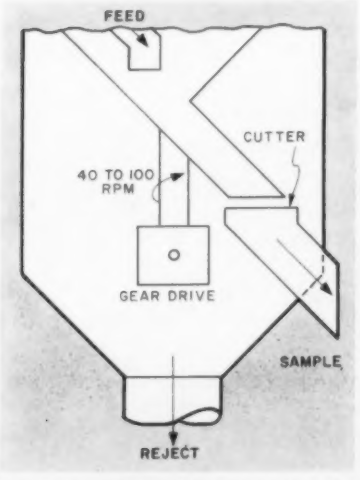


Fig. 3. A rotating hopper and spout

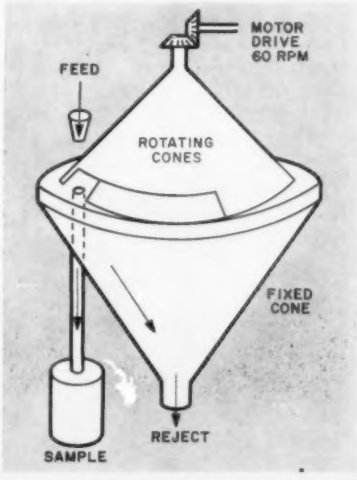


Fig. 4. Rotating slotted-cone sampler

Preparation of Samples

Coal sample collection operations are usually blamed for an inaccurate analysis. Without minimizing the importance of proper sampling, it can be stated that frequently an equal share of the blame should be placed on questionable preparation of the samples. Sample preparation includes all the crushing and dividing operations performed on the gross sample both in field and laboratory.

Normally, nine or ten preparation operations are performed in properly reducing the sample to a minus 60-mesh pulp. Extensive tests of these operations in a large, well-equipped laboratory showed that about two-thirds of the permissible errors were occurring in these preparations, whereas it had been assumed that these errors would be only one-fifth of the total errors.

Mechanical Sampling

With such large preparation errors, it is difficult to obtain the desired ash content value accuracy even with most careful sample collection. The use of acceptable mechanical sample dividers can reduce these errors.

Whenever practicable, it is desirable to provide mechanical methods for collecting and dividing coal samples. Mechanical samplers will naturally obtain a much larger sample

* Division Engineer and † Assistant Engineer, both with Consolidated Edison Co of New York, Inc

than with manual procedures. However, with mechanical sampling, special precautions must be taken to minimize segregation and loss of moisture. Adequate crushing facilities must be provided to assure dependable operation under all conditions.

To handle the large gross samples from mechanical samplers, the mechanical sample divider is receiving increased attention. In several instances, these dividers have replaced the traditional riffle, thus reducing labor needs and sampling errors.

A typical completely-automatic sampling installation collects twenty 125-lb increments per hr at a belt transfer point, crushes the coal to minus 8-mesh size and divides the sample in two successive steps to give a final sample of about 3 lb to represent about 2200 tons taken from a barge. This sample is air-dried, pulverized and a final division of the minus 60-mesh size pulp made in the laboratory.

At this installation, tests for bias and random error were made at each stage of the preparation and after several modifications it was found that the total preparation error was within the desired limit of one-fifth of the over-all sampling error.

A satisfactory mechanical sampler, whether used for sample collection or as a sample divider, should satisfy the following requirements:

1. The sampling slot or cutter must have an opening at least three times the maximum particle size of the coal sampled. For resampling minus 8-mesh product a cutter opening of ½ in. or larger is desirable.

2. The sampler should be so located in a coal stream that there will be no appreciable bias in the sample with respect to size consist or ash content. A typical "first trial" location of a sample divider at the discharge of the sample crusher gave 40 per cent through 20 mesh in the "save" compared with 29 per cent in the "reject" portion. By slight changes, these values were brought within ± 2 per cent of each other. The discharges of another sampler showed ash contents of 10 per cent for the "save" and 8 per cent for the "reject." The chute design to this sampler was modified and the bias in the respective ash contents disappeared.

3. Sample will consist of at least 40 increments taken at regular intervals over the entire sampling period to give not less than the quantity specified for the particular type of coal. In other words, a mechanical sampler would not be expected to give accurate results with one or two cuts taken during emptying a single coal car of 60-ton capacity. Sample dividers operating at 20 to 120 rpm should not be turned on for only a fraction of a minute.

4. Sample crushers should be set to give a product uniformly smaller than a designated value. For example, hammer mills designed to give a minus 8-mesh product will ordinarily give 5 per cent plus 8-mesh and zero per cent plus 4-mesh size. Regular sieve tests should be made on the crushed coal and corrective steps taken when over-sizes exceed 5 per cent.

Four of the more common types of mechanical sample dividers now in use are illustrated. It should be emphasized that, although each of these samplers has been installed and operated satisfactorily at some plant, a new installation should be made only in accordance with the requirements given above.

Sample divider A — Horizontally-moving cutter. Figure 1 shows a section view of this cutter. The cutter moves backward and forward across a falling stream of coal and discharges the sample into a suitable receiver. It is essential that in the neutral or stopped position the cutter be completely out of the coal stream.

Sample divider B — Rotating cutter. Figure 2 shows two cutters attached to a hollow shaft. Each cutter is designed to obtain 5 per cent of the gross sample and discharge the sample through the hollow shaft. One or more cutters may be used, depending on the size sample desired.

Sample divider C — Rotating hopper and spout. Figure 3 shows the rotating hopper which receives the crushed sample and discharges through a spout over one or more stationary cutters. Each cutter will collect from 5 to 10 per cent of the gross sample to give an independent sample.

Sample divider D — Rotating slotted cone. A slotted cone on a vertical shaft is designed so that a falling stream of coal will be deflected by the cone and the sample increment will fall through the slot. Figure 4 shows two concentric cones with 90 deg cut away for each slot. By simply adjusting one cone, any size slot may be obtained to give a sample division ranging from 2 to 50 per cent. The original sampler was developed by the British Coal Board and the concentric cone modification is produced currently in England.

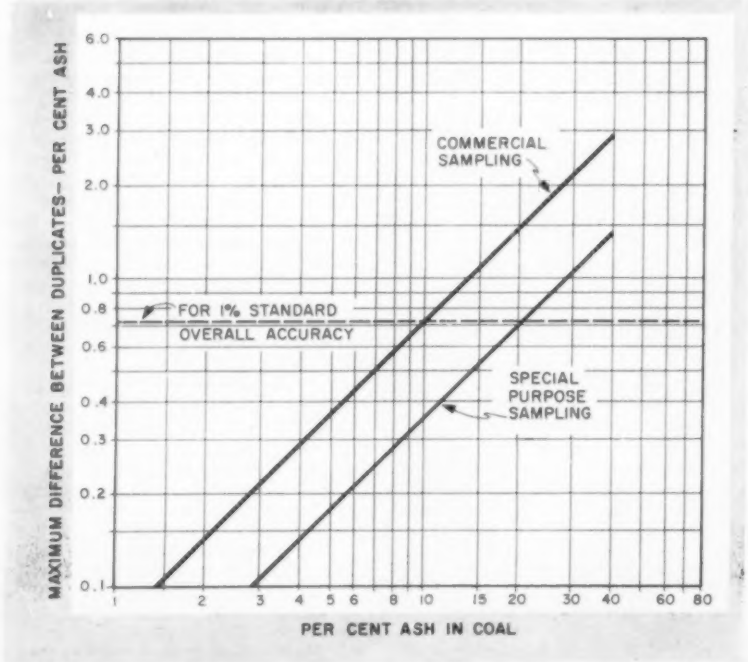


Fig. 5. Maximum permissible difference between 95 out of 100 lab samples

Testing Coal Sampling

Accuracy of a mechanical sampler installation should be determined even though the sampling conditions appear to be ideal. This is particularly desirable where raw coals, high-ash coals or railroad-car shipments are being sampled as there is a definite possibility of appreciable bias in these sampling operations.

To evaluate the accuracy and precision of the preparation of coal samples, it is necessary to obtain duplicate subsamples of several gross samples and measure the over-all systematic (bias) and random errors. The systematic errors are usually the most serious as they are not readily apparent; they may be built-in errors in a mechanical procedure or they may result from the working habits of the operator who will generally carry out operations in the same manner each time. The random errors may be larger but will tend to average out over a series of samples.

Procedure for determining the systematic and random errors consists of collecting and analyzing representative portions of the "save" and "reject" samples after division of six

or more gross samples. For determination of the systematic error, these "save" and "reject" samples must be collected in the same order, that is, the product off the same side of a riffle or the "save" side of a mechanical divider will be given the same designation for each test.

Ash analysis of the coal samples is generally used in determining accuracy and precision of sampling as this value provides the most sensitive measure of changes in quality.

Ash content of the duplicate subsamples can be tabulated and the systematic errors computed as shown in the table.

A properly-designed and tested mechanical coal sampling installation will insure more accurate coal analyses for both the coal buyers and sellers, and for the supervisors of the efficiency of a power plant. With increased confidence in the sampling, it has been possible to reduce the number of analyses in the laboratory with an appreciable reduction in manhours for coal testing.

Both the American Society of Testing Materials and the British Standards Association are actively engaged in reviewing the present standard sampling methods. It is expected that new standard methods will emerge in the not too-distant future to cover more adequately the mechanical sampling and also improve the present specifications for manual sampling of coal. THE END

Method for tabulation of subsample ash content and detection of appreciable bias

Column No.:	1	2	3	4
Test or Gross:	Save (3)	Reject (R)	S-R	$(S-R)^2$
Sample No.				
1		(Ash content of subsamples appears here)		
2				
3				
4				
5				
6				
•				
•				
n				
Sum				

The probability of existence of bias is indicated by the magnitude of value "F" where:

$$F = \frac{\frac{(\text{Sum of Column 3})^2}{n}}{\left[\text{Sum of Column 4} - \frac{(\text{Sum of Column 3})^2}{n}\right](n-1)}$$

The existence of an appreciable bias is indicated in 95 out of 100 cases if the value of "F" is larger than shown below:

Max Permissible, F	No. of Tests or Gross Samples
6.61	6
5.12	10
4.38	20
4.18	30

If the "F" value is excessive, the sample preparation operations should be carefully checked to ascertain possible causes of bias.

The random error of the sample preparation operations is computed as follows:

$$\text{Random Error (Max Expected Diff 95 out of 100 Cases)} = 2\sqrt{\left[\text{Sum of Column 4} - \frac{(\text{Sum of Column 3})^2}{n}\right](n-1)}$$

If this random error value exceeds the value given in Figure 5 for the average ash content of the coals tested, the precision of the sample preparation operations is below the recommended standard and corrective steps should be taken.

Assembling Underground Heat-Distribution System At Ground Level Cuts Trench Maintenance

Lowering 250 ft of pre-assembled insulated heating piping into trench

FIELD WELDING and testing a complete underground heat-distribution piping system consisting of inner pipe, insulation and casing, at ground level, then laying it into a trench like an ordinary pipe line, cuts installation costs. Cave-ins, flooding and other trench maintenance, and bell holes are eliminated.

At Truax Air Force Base, Madison, Wisc., C. A. Hooper Co, prime contractor, completely assembled and tested at ground level, several runs of 500 ft (approximate weight, 30,000 lb). This was made up of EBKO welded steel 14-in.-diameter casing units with 8-in. inner pipes manufactured by E. B. Kaiser Co.

Using three cranes, one half of each run, including one expansion loop (26 ft by 18 ft by 26 ft), was lowered into a 4-ft-deep trench while the second half was still at ground level.

Thus, assembly of the piping system no longer relies on climatic conditions favorable to trenching and thus allows the contractor more freedom in scheduling his operations. In addition, work which ordinarily is completed in a trench where space is at a premium, can be accomplished at ground elevation with ease.

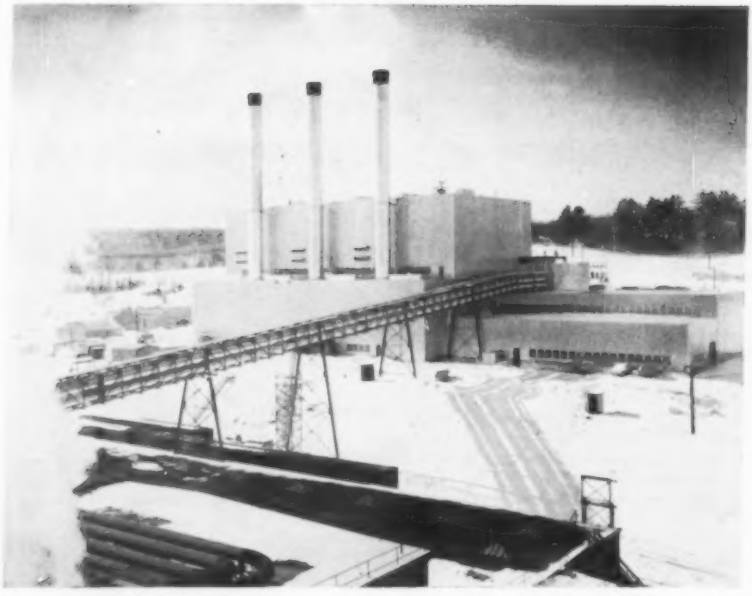


Fig. 1. New power plant of Great Northern Paper Co at Millinocket, Maine. Bridge carries process steam and electric power cables to the mill

When booming paper production schedules strain existing hydro and thermal generating facilities and a need for additional process steam is present, an interesting engineering situation arises. Add an obsolete boiler plant to this picture and complete modernization of power plant is indicated. Here one progressive manufacturer solves the problem

Great Northern Paper Adds New Plant For Process Steam and Power

By ROY V. WELDON * and W. E. KNIGHT †

NEW STEAM POWER PLANT, recently placed in commercial operation, is providing an adequate supply of process steam and a substantial block of firm generating capacity needed by Great Northern Paper Co at its Mill No. 1 at Millinocket, Maine.

Below average rainfall in recent years had resulted in an overdraft of storage used in power production at Great Northern's six hydro stations on the West Branch Penobscot River. The new plant, which in many respects resembles the plant recently installed at Mill No. 2 ** in East Millinocket, a few miles to the southeast, now increases the previous power network capability by approximately 36,000 kw.

The old power plant at Millinocket, which has served since the turn of the century, can now be retired except for bark burning units which supply a small amount of steam generation. Both Mill No. 1 and Mill No. 2 require 40-cycle electric power and the new units connect to the network at this frequency.

In addition to the need for firm generating capacity, the existing obsolete steam plant was inefficient by modern standards and incapable of meeting steam demands for proposed increases in paper mill production.

** See POWER ENGINEERING for Sept., 1955 and Davidson's ASME paper No. 55-SA-75

The new high pressure steam power plant adequately satisfies all present requirements for process steam, and provides a moderate excess of firm generating capacity, which will permit greater latitude in operation of the hydro plants.

Because the new installation at Millinocket is located on previously unused land, the site now occupied by the old steam power plant will eventually provide space for growth of the mill.

Two Years, Start To Operation

The over-all designs for the new steam power plant, developed jointly by Great Norther Paper and Stone & Webster Engineering Corp, embody the lowest investment compatible with reliability and low operating cost.

Duplication of the design of the basic superstructure, originally prepared for the steam plant at Mill No. 2, permitted early design of the foundations and the beginning of the construction work in the field.

Early purchase and delivery of building steel, precast roof slabs and insulated aluminum panel siding made it possible to perform most of the equipment installation, wiring and piping erection indoors. As a result, commercial operation was attained in less than two years from the time of authorization to proceed with purchasing, design and construction.

Basically, the aggregate steam generating capacity of the plant was calculated to meet the present maximum peak mill requirements, including an allowance for a proposed speed increase for the existing paper machines. The highest steam pressure presently needed in the mill is 210 psig. Obviously, boiler output at any pressure in excess of mill requirements would be solely in the interest of procuring byproduct electric power generation.

Process steam pressures and temperatures required at the new steam power plant at Mill No. 1 are identical to those at Mill No. 2 and this permitted some duplication in design. Extensive studies were made to determine the most practical and economical steam pressure and temperature for the power plant previously erected at Mill No. 2.

Cost Estimates Prepared

As experienced with many industrial power plant studies, it was somewhat difficult to properly apportion the total capital and operating costs between process steam supply and electric power generation so that the true cost of power generation alone could be determined. Very accurate figures were necessary because alternate plans for hydroelectric development were being considered at the time.

Process steam at 210 psi gage and

* Executive Vice-president, Great Northern Paper Co. † Mechanical Engineer, Stone & Webster Engineering Corp

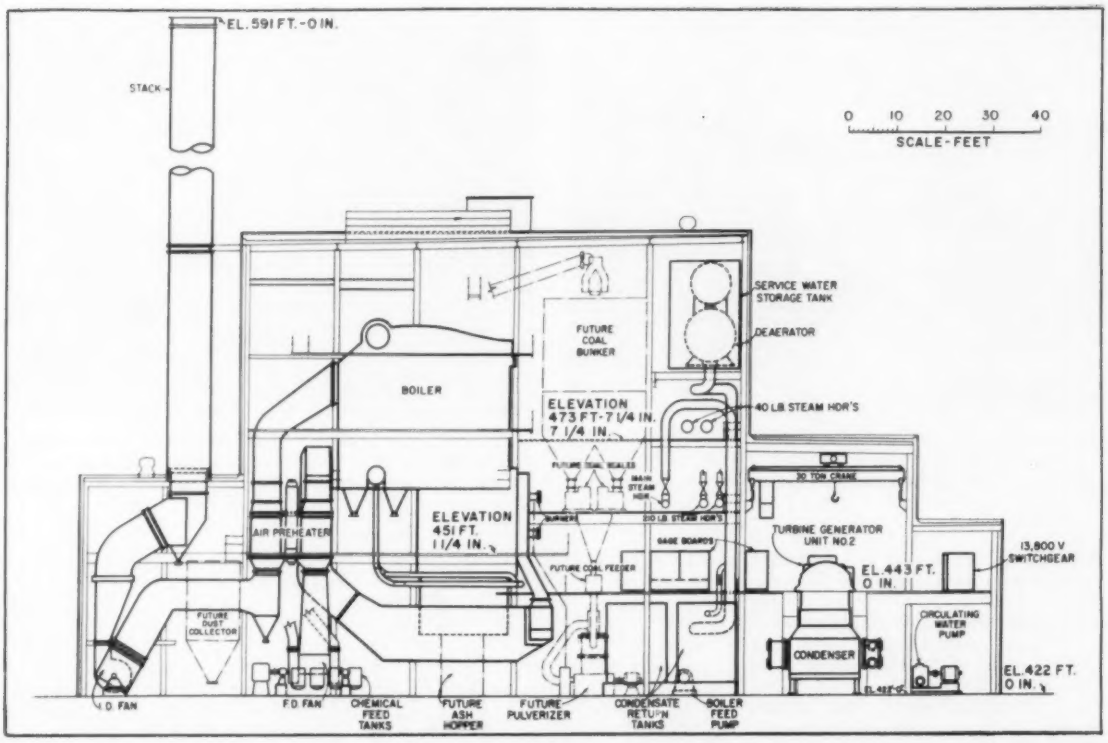


Fig. 2. Cross section view of new Millinocket power plant. Note location of control room with respect to major equipment

480 F was required for the mill, regardless of whether or not the steam power plant was also to generate electric power. Therefore, a layout of a 210-psi-gage steam generating plant to meet mill process steam demands was made and a complete construction cost estimate was prepared and reduced to annual fixed charges. To these charges were added the calculated annual operating costs for this minimum plant, to determine the total cost of the steam supply only.

Similarly, alternate layouts, estimates and costs were compiled for steam generating plants designed for throttle conditions of 600 psig at 700 F, 850 psig at 770 F and 1250 psig at 855 F. The higher initial pressures permitted the inclusion of electric power generating equipment and as the initial conditions were increased, so were the sizes of the turbine-generator units and consequently the available by-product electric power.

The difference in annual costs between the base low-pressure steam generating plant and each of the succeeding high-pressure power plants were compared with the annual kilowatts which could be produced, and the cost per kwh was readily ascertained in each case. These studies resulted in the design of the Mill No. 2 steam power plant for a throttle pressure of 1250 psig at 855 F. The intial temperature of 855 F was that calculated to be necessary in order to obtain extraction process supply steam at the required 210 psig at 480 F, and 40 psig at 300 F.

Although the new boilers for Mill No. 1 essentially duplicate those on the earlier job, the turbine-generator units, power piping and arrangement of electrical gear are entirely different, as required to meet local conditions. The changes were accommodated within a building having an identical cross section to that at Mill No. 2.

Boilers, Turbines and Auxiliaries

A schematic representation of the fundamental steam flow diagram of the new plant is shown in Fig. No. 7. Three Combustion Engineering, Inc steam generating units, each nominally rated at 300,000 lb per hr of steam generation at 1300 psig and 855 F, supply steam for two General Electric Company 2400-rpm turbine-generator units. Each electric generator has a rating of 19,531 kva at 30 psig hydrogen pressure.

Unit No. 1 is driven by an 18,000 kw straight non-condensing turbine which normally exhausts at 210 psig, with provision for an exhaust pressure increase to 250 psig in the future. Unit No. 2 is driven by a double automatic-controlled extraction, condensing turbine arranged to permit the extraction of steam at 210 psig from the first point and the extraction or induction of steam at 40 psi from or to the second point. These extraction pressures may be increased to 250 and 50 psig, respectively, in the future if a change in process steam pressures should become desirable.

In the event of outage of either or both of the turbine generator units, process steam is furnished to the mill through pressure reducing and desuperheating stations.

The steam generators are supplied with feedwater by four steam turbine-driven boiler feed pumps, one for each of the three boilers, plus a spare. The mechanical drive turbines were selected for this service because the barrel-type boiler feed pumps are designed to operate at a speed of 3600 rpm, which could not be furnished directly by electric motors driven from the 40-cycle network.

Paper Machine Drives

Nine of the eleven paper machines were previously driven by Corliss steam engines through rope drives. These engines were incapable of meeting the increase in power required by the proposed higher machine speeds. They also contaminated the condensate system with larger quantities of cylinder oil. Therefore, the engines were replaced by higher horsepower mechanical drive steam turbines designed for initial admission steam conditions of 200 psig and 480 F. These new turbine drives exhaust oil-free steam at 40 psig to the dryers and to other mill facilities.

Steam rates of the turbine drives may later be changed by increasing the admission pressure and temperature, or by increasing or decreasing

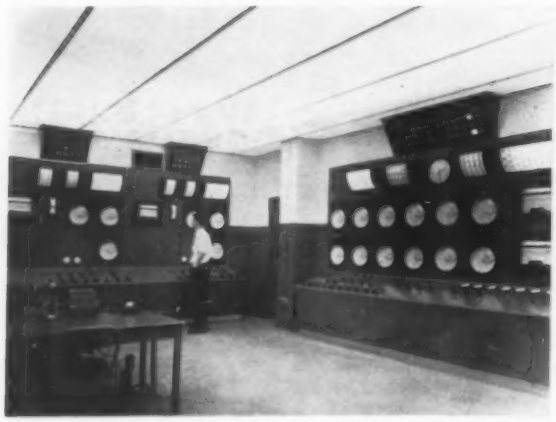


Fig. 3. Control room view. Gage boards for boilers 1 and 2 are at left. Vacant space is for future pulverizer controls. At right are gages for functions common to power plant and mill

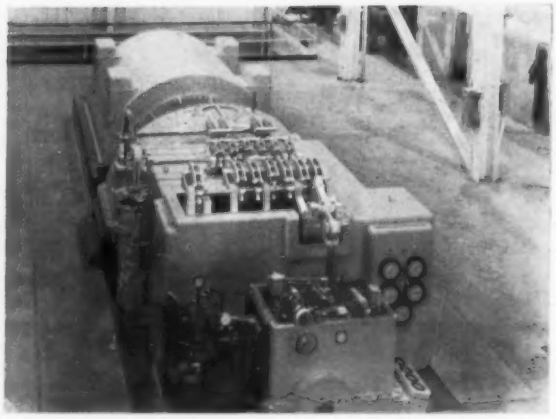


Fig. 4. View of 19,531 kva double extraction condensing No. 2 unit. 40 psig extraction, also an induction opening, will receive excess exhaust from the paper machine drives

the exhaust pressure if the mill heat balance requires adjustment in the future.

The mill demand for process steam in the summer is approximately two thirds of that required in the winter. This accounts for the selection of three steam generating units, because maintenance may be done successively on each during the summer without affecting production.

There is always sufficient mill demand for 210 psig steam to insure maximum capability from noncondensing turbine-generator Unit No. 1. Adjustment for the entire annual variation in mill steam requirements, therefore, must be performed by turbine-generator Unit No. 2 and, to also insure maximum generation from the second unit, the unit was equipped with a condenser.

As a result of the reduced flow of process steam required by the mill in the summer, sufficient boiler capacity is normally available to permit condensing operation. In extremely hot summer weather, there may be short periods during which an excess of 40 psig steam will be returned from the mill. The induction feature on turbine-generator Unit No. 2 will permit this to flow through low pressure turbine stages to the condenser, producing useful work.

Power Supply Sectionalized

The steam power plant operates 24 hr a day, seven days a week, except for a few holidays and without an annual shutdown. It was necessary, therefore, that the power piping and station service power supply be sectionalized in a manner permitting shutdown of segments of the cycle for maintenance without affecting mill production.

In general, the power piping systems are laid out in loop systems and each side of each loop is sized nominally to carry half the maximum flow. The sectionalizing valves permit scheduled outage of piping as well as equipment without a power plant shutdown.

As previously implied, the mill summer steam demand is approximately 65 per cent of the winter demand and one side of any of the loops can carry the entire mill demand in the summer with only a nominal increase in pressure drop due to pipe friction.

Main switchgear may be sectionalized with bus tie breakers. The three unit substations supplying power to the station auxiliaries are so connected that two of these units are supplied from one side of the tie breaker and the remaining unit from the other side.

Methods of Water Treatment

The water treating plant occupies an unusually large proportion of over-all plant space, because make-up to the cycle is approximately 20 per cent of the total process steam to the mill. Water from the West Branch Penobscot River upstream of the mill is the source of raw water for the mill and, incidentally, also for the town water works. This water is soft, but contains a considerable amount of vegetable color and sufficient silica to preclude the use of zeolite treatment.

Two 600 gpm clarification units discharge to open-top sand filters and the effluent flows by gravity to a concrete clear well located under the floor of the water treatment portion of the building. Clear water pumps supply two sets of demineralizer equipment, each set having a rated capacity of 600 gpm.

It is interesting to note that the utilization of cation-anion resin-exchange type demineralizing equipment is a predominant factor in making possible the generation of high pressure steam in process plants which require a high percentage of make-up. This is not practicable with evaporators.

When high purity process steam is supplied to the mill equipment and condensed, the condensate is ordinarily capable of dissolving sizable quantities of iron and copper during its passage through paper machine dryers, heat exchangers and piping. This iron and copper pick-up tends to deposit in various places, especially on hot surfaces in the furnace tubes. This phenomena frequently results in tube failure. The introduction of a neutralizing amine such as morpholine or cyclohexylamine to the boiler feedwater alleviates this source of trouble by raising the pH of the condensate. These amines vaporize with the water in the boilers, pass with the process steam to the mill and return with the condensate to the steam power plant. The desired pH of the condensate is always maintained in this manner and iron and copper pick-up is kept to a tolerable minimum.

Centralized Control

A control room containing all power plant main controls, meters, recorders and important indicators is located centrally between the turbine-generator units and the boilers, as pictured in Fig. 3.

The arrangement of the centralized control room permits the future addition of instruments for a third turbine-generator and a fourth boiler merely by adding to the length of existing gage boards. Practically all operating procedures are remotely controlled from the centralized control room with minimum effort.

The metering is sufficient to permit continuous and adequate checks of the plant equipment heat balance and the demand for process steam under all conditions of load. The ability to reconcile quickly the fuel burned with the end use of steam and electric power is conducive to close supervision of operation to insure optimum efficiency within the limits of the equipment.

Adjacent to the generator control

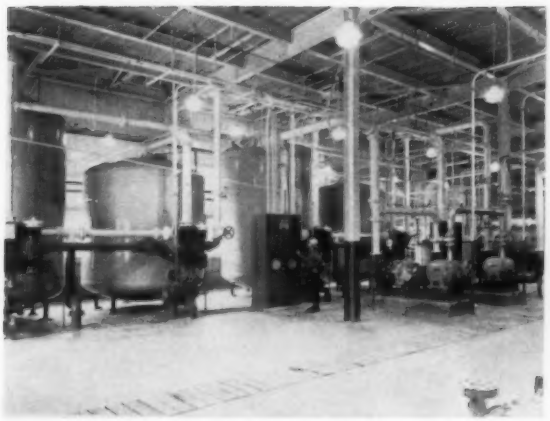


Fig. 5. Photo showing the cation-anion exchange units located in water treating plant. Booster pumps seen at right deliver demineralized make-up to system at the deaerator

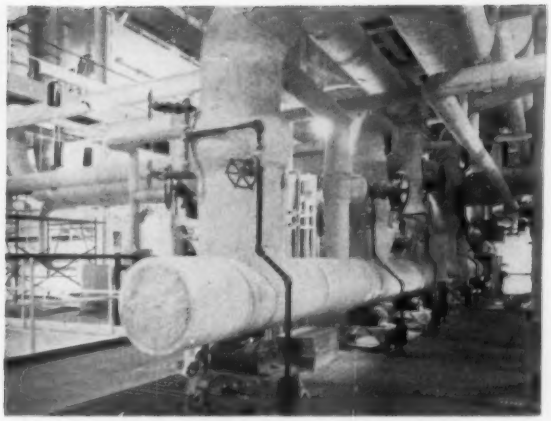


Fig. 6. View of piping gallery prominently showing the main steam header. Note excellent arrangement of bottom supports to header. Reducing valves are seen in background

board is a supervisory panel for remote control and indication of the North Twin hydroelectric station, about three miles distant and the Millinocket substation across the river from the mill. This system can be expanded for control of other hydroelectric stations as need arises.

Associated with the supervisory system is a map showing the entire power generating and transmission network made up of 1¼-in. Laminicoid squares illuminated by red and green lamps to indicate position of all disconnect switches and circuit breakers. The indications are automatic for the local and supervised switches and manual for the independently staffed stations.

Fuels and Facilities

Although fuel oil will be burned initially, space and other provisions are made for the future addition of coal handling facilities, storage bunkers, pulverizers, fly ash collectors and ash disposal equipment. The boiler furnaces are sufficiently large to attain full rated output from coal fuel.

Two 55,000-bbl fuel oil tanks, near the river within earthen dikes, are located downhill of the steam power plant and the paper mill buildings. A fuel oil unloading station near the storage tanks utilizes two railroad tracks on 20-ft centers. Twelve tank cars on either track can be unloaded simultaneously. THE END

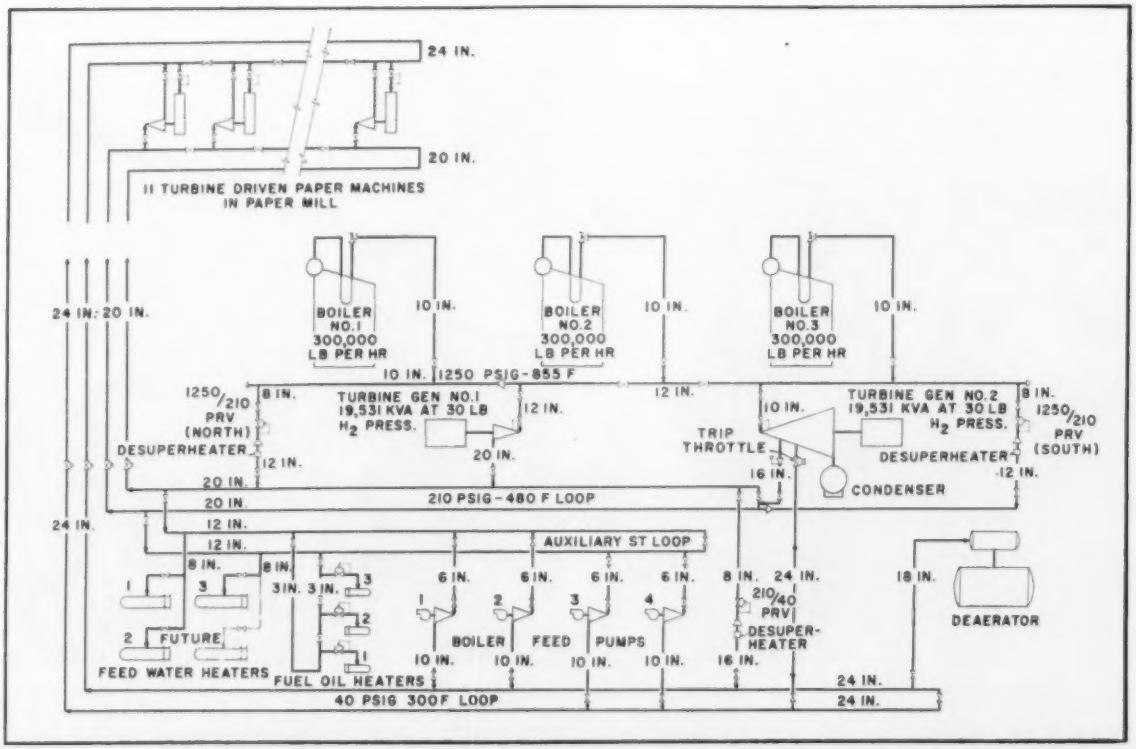
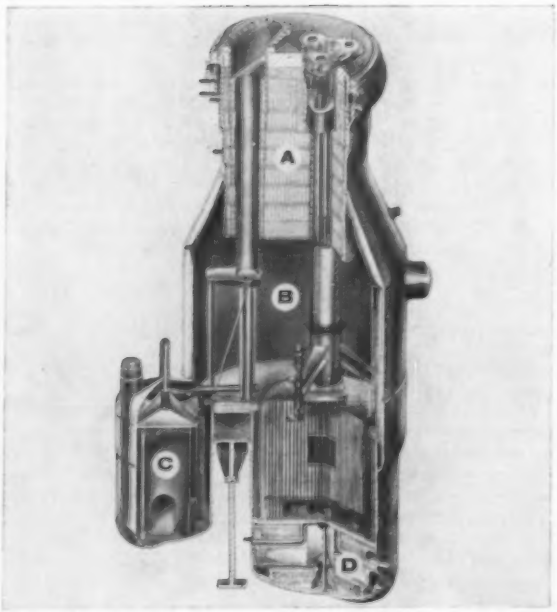


Fig. 7. Steam flow diagram of Great Northern Paper's new power plant. Distribution system has double-loop flexibility

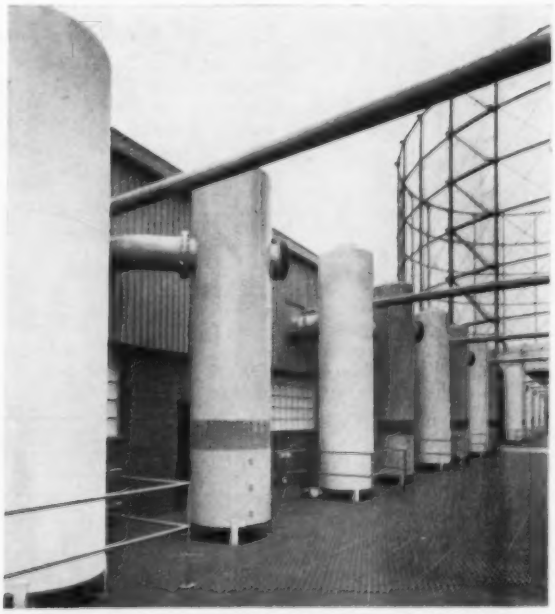
1 Dwarfing ordinary transmission lines, towers 160 ft high, 180 ft wide will serve extra high voltage experimental line to be built in Massachusetts. In charge of EHV (750-kv) project is Pier A. Abetti of G-E, shown here with same-scale models of new and 110,000-v towers

2 Addition of two 225,000-kw boiler units makes Ohio Power Co's Muskingum River plant biggest in American Electric Power system, 880,000 kw. New units are outdoor, use Kaiser Aluminum lagging and jacketing for protection

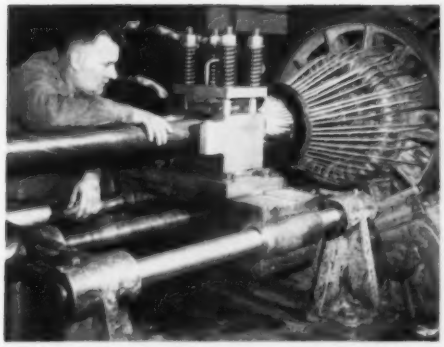
POWER ENGINEERING'S



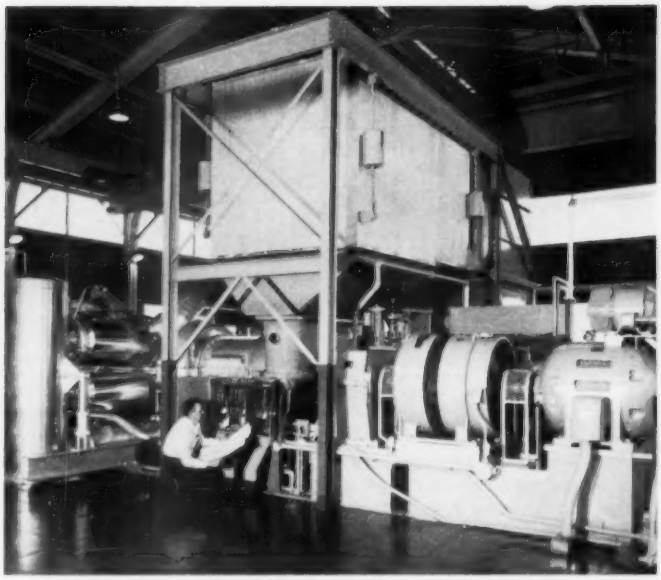
5 Inside the reactor vessel made by Combustion Engineering for Enrico Fermi Atomic Power Plant in Mich. A is plug container and conical transition section, B upper reactor vessel, C transfer rotor container, D lower reactor (fuel). Height of the vessel is 37 ft 8 in., weight is 182,099 lb



6 Quietest plant of its kind is claim of S. California Gas Co's Ducommun St plant in Los Angeles. Intake and exhaust of 8 large gas engine-driven compressors was given the silence treatment by use of Burgess-Manning silencers and snubbers on each compressor. Neighbors like it fine

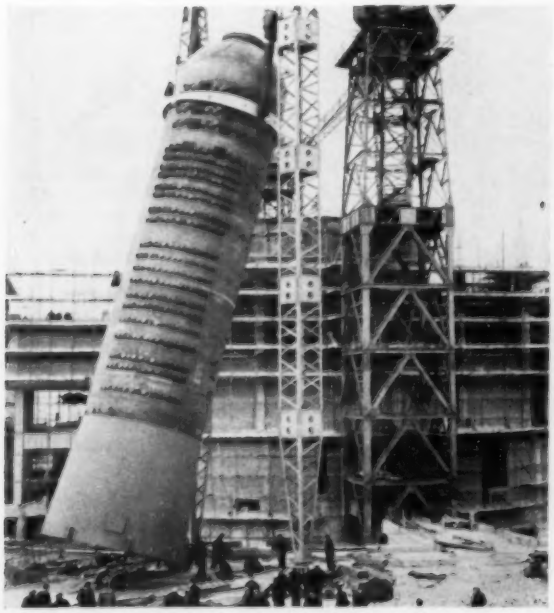


3 4-in lock-coil cable, largest of its kind ever made, leaves "Queen Mary" wire-stranding machine at Trenton works of U. S. Steel's American Steel & Wire. Cable will be used in construction stages of Arizona's Glen Canyon Dam



4 Gas turbine-operated compressor stations such as this one at Belen, N. M., are helping to meet West Coast demands for additional natural gas. These new G-E turbines are working in El Paso Natural Gas Co's daily production of 2,673,000,000 cu ft of gas for consumers in 5-state area

NEWS REEL



7 Crane lifts 133-ton heat exchanger into position at Berkeley Nuclear Power Station in Gloucestershire, England. Unit is 70 ft high, has 17½-ft diam. Plant is due for completion in 1960, will have two reactors and 16 of these heat exchangers. Output of station will be 275,000 kw

8 Three men in a tub are workers at Lukens Steel Co. Tub is heaviest pressed head ever formed, weighs about 16,340 lb. It is one of two hemispherical heads to be used in power boiler equipment. Each is 71¾ in. in diam, with minimum gage of 5⅞-in., rolled from carbon steel plate 7-in. thick

Indoctrination and training for the young engineer in his first job with the company is really everyone's responsibility. Out of this realization The Detroit Edison Co has built a model procedure

Fig. 1. Getting off to a good start is very important. Here L. L. Knickerbocker (r) introduces James Wemyss to E. R. Moore, Manager of Engineering

How Detroit Edison Handles The Engineering Graduate

By **LEWIS L. KNICKERBOCKER** *

FIRST FIVE years after an engineer completes his formal college education are considered to be the most important in his professional career; so it is natural that he should want to begin by getting into the right job with the least possible delay. Therefore, the first objective of the college graduate development program at Detroit Edison is to help the new engineer select a field of endeavor best suited to his talents and training.

To accomplish this, the company uses training methods and procedures which are tailored to meet individual requirements and which give both the employee and the company an opportunity to learn all the pertinent facts about one another in a relatively short time.

When the graduate arrives at the company's general offices in Detroit, he is welcomed by an Employment Department representative who will work closely with him throughout a three-month orientation period. This representative not only helps the new employee become acquainted with company personnel, policies and operations but offers assistance in many matters incidental to employment.

Getting an employee off to a good start in the company frequently involves helping him to make new friends, finding him suitable living quarters and familiarizing him with the community, as well as making him feel at home in every way possible. This personal relationship with each individual is not only emphasized during the orientation period but is carried through until the employee is well established in his permanent job, and afterwards.

By getting to know the employee personally the employment advisor is also in a better position to assist him in selecting a field which will continue to stimulate his interest and in which he can make the best use of his aptitudes and abilities.

Also helpful in matching abilities with specific job requirements are the placement tests which are given during the first three days of employment. These tests attempt to measure a young engineer's aptitudes, interests and personality, and the results are carefully analyzed by the employment advisor and thoroughly discussed with the new employee.

Placement Tests

Although these tests at Detroit Edison are still in the developmental stage, it is hoped that a profile of a young engineer taken from them may prove to be an aid in determining if he should be placed in Sales, Research, Design, or some other type of engineering.

These tests, however, cannot take the place of an individual's judgment, but only give additional facts to make a wiser decision. Other factors have to be considered, such as previous experience and the academic record, which may indicate a strong interest in a particular field.

After the first few days of general introduction, the Employment Department representative arranges a two-week schedule of brief visits to the departments that employ a large number of engineers. Purpose of these visits is to acquaint the graduate with the general activities and responsibilities of the various engineering groups, so that he will be able to indicate the departments that interest him most.

When the graduate has made known his preference of departments, the Employment Department representative then re-schedules him for a two- to three-week stay with each department. This gives the graduate a longer period of time to visit with the supervisors and other engineers, as well as an opportunity to participate in discussions and field trips.

Personal Appraisal

Following each of these visits, the graduate is appraised by one or more members of the department's supervisory staff. This appraisal considers the following characteristics (Fig. 6): appearance, punctuality, interest in the work, coöperation in the work group, and capacity for development. A copy of the appraisal is sent to the

Fig. 2. Training on the job is arranged to allow full participation in the work

* Personnel Assistant, Employment Department, The Detroit Edison Co

Employment Department. At the same time, the graduate discusses with the employment representative his reaction to being placed in the various departments, and of course the representative must also consider the types of openings available when the graduate is ready for permanent placement.

Here again, tests results are reviewed, for these tests are still considered a helpful tool in matching abilities to job requirements.

Departmental Training

Each department conducts its own training program on a formal or informal basis and uses a closely supervised type of instruction which permits full-scale participation in the work.

Take for example the engineer who begins his training in one of the six power plants operated by the Production Department. The entire training period, usually about 18 months, is spent indoctrinating the college graduate into the department. This program is designed to cover the following important objectives:

1. To obtain an over-all knowledge of power plant operation.
2. To become acquainted with the principles of supervision and obtain experience in work-direction type of work.
3. To learn how to operate the equipment in the plant.
4. To become familiar with the various test procedures and studies necessary to maintain maximum plant efficiency.
5. To obtain a knowledge of the duties of all plant operating and maintenance groups.
6. To get acquainted with the largest number of plant personnel and demonstrate ability to get along with people.
7. To become acquainted with the problems of the plant staff and General Office staff.

In setting up a schedule, the department assigns duties which not only give the trainee the over-all view of plant operations but impress on him the importance of the many human aspects involved.

As a work-director supervisor, he learns the value of teamwork among the many specialists, technicians and engineers; gains leadership experience; becomes familiar with the various tests and studies used in maintaining maximum plant efficiency; and has an opportunity to put the engineering principles he learned in school to a practical use. By taking an active part in the various phases of plant work, he also gains a sense of accomplishment and at the same time the plant staff is better able to determine his fitness for a power plant assignment.

In order that the trainee may better understand what is expected of him he is given a training booklet which explains the purpose of the program, how he will be trained, the basis upon which he will be rated by the plant personnel and the nature of the assignments he will have after completing the training program.

In instances where the new engineer demonstrates exceptional ability or has had previous power plant experience, the plant superintendent and the technical engineer of power plants review the training procedure and revise the schedule accordingly. In such cases, the trainee is usually given special assignments which broaden his experience and stimulate his imagination and interest.

An annual evaluation is made of the entire training program because it is recognized that changes may be necessary from time to time. As each graduate completes his training, he is required to send a brief memorandum to the Technical Engineer of Power Plants which contains his impression of the program with suggestions for improvement. These recommendations are reviewed once a year and changes are made in the program as the need becomes apparent. These changes are also included in a revised copy of the training booklet and

SUGGESTED TRAINING AND PROGRESSION SCHEDULE FOR ENGINEERING TRAINEES
from Detroit Edison's Production Department Training Guide

ASSIGNMENT	Weeks Based on Training Period Length 1½ Years
Plant Offices	4
Superintendence	
Operations	
Maintenance	
Technical	
Operations	26
Coal and Ash Handling	
Boiler Room	
Turbine Room	
Electrical Control Room	
Foremen	
Maintenance	13
Mechanical	
Electrical	
Turbine and Boiler Overhauls	
C & M Department	
Foremen	
Technical	26
Instruments and Control Systems	
Testing and Office	
One Week at each of two other plants	2
General Offices—Load Scheduling	5
Vacation	2
TOTAL	78

TYPICAL PROGRESSION SCHEDULE

Approximately 1½ to 2 years

Engr. Assistant | Assistant Engineer — Associate Engineer

Department Training Program

Employment Department Orientation Program

Fig. 3. Trainees work with staff engineers on various power plant problems

Fig. 4. Engineer in training inspects generator windings in following overhaul

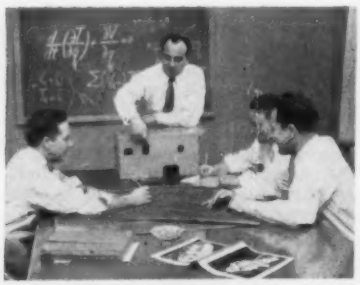


Fig. 5. In lab and research department, junior grads help with design problems

COLLEGE GRADUATE DEVELOPMENT PROGRAM REPORT

TO: .....

To be filled out and returned to Employment Department upon completion of Assignment

EMPLOYE .....

COLLEGE .....

COURSE OR DEGREE ..... YEAR .....

DEPT .....

ASSIGNED FROM ..... TO .....

PREVIOUS COMPANY WORK ASSIGNMENT: .....

CHECK THE SQUARES BELOW WHICH NEARLY DESCRIBE THE TRAIT CONSIDERED

CHARACTERISTICS	OUT-STANDING	AVERAGE ABOVE	AT	BELOW	REMARKS
APPEARANCE	☐	☐	☐	☐	
PUNCTUALITY	☐	☐	☐	☐	
INTEREST IN YOUR WORK	☐	☐	☐	☐	
COOPERATION IN WORK GROUP	☐	☐	☐	☐	
CAPACITY FOR DEVELOPMENT	☐	☐	☐	☐	

1. DO YOU WANT TO CONSIDER THIS EMPLOYE FOR PERMANENT ASSIGNMENT IN YOUR DEPARTMENT UPON COMPLETION OF TRAINING?
   ☐ YES ☐ NO .....

2. IF SO, IN WHAT OTHER DEPARTMENTS SHOULD HE BE GIVEN WORK ASSIGNMENTS DURING HIS TRAINING PERIOD TO BEST FIT HIM FOR PERMANENT ASSIGNMENT IN YOUR DEPARTMENT?

3. IN YOUR OPINION, FOR WHAT TYPE OF WORK IS EMPLOYE BEST FITTED?

GENERAL REMARKS .....

SIGNATURE OF RATING EMPLOYE

Fig. 6. This personal appraisal form is filled out and returned to Employment Department after trainee has completed a 2–3 week introductory stay in any one of the departments

FOLLOW-UP REPORT

NAME ..... **PAY ROLL NO.** .....

DATE OF BIRTH ..... **EDUCATION** .....

FROM	TO	DEPT.	OCCUPATION	REASON FOR CHANGE

EXPLANATION: The employe named above is new in your department. Because of our part in selection it is important to us that this employe be up to your departmental standards for this particular occupation. We may also be able to be of further service to you by helping the employe make the adjustments necessary on a new job. To these ends we would appreciate your cooperation in answering the following questions. Your answers should be in your own words and represent your own opinions. This written report will be asked for at the end of 3½ months, 5 months and 1 year, and will become a part of the employe's permanent record.

FIRST REPORT DUE

HOW DOES THIS EMPLOYE MEASURE UP TO YOUR DEPARTMENT STANDARDS?

1. QUANTITY AND QUALITY OF WORK .....
2. ATTITUDE TOWARD THE WORK .....
3. ABILITY TO COOPERATE AND GET ALONG WITH FELLOW EMPLOYES .....
4. APPEARANCE, MANNERS, OR DRESS .....
5. PUNCTUALITY AND REGULARITY OF ATTENDANCE .....
6. HEALTH OR PHYSICAL CONDITION .....

DESCRIBE ANY TRAINING DIFFICULTIES YOU MAY HAVE EXPERIENCED WITH THIS EMPLOYEE .....

HAVE ANY SHORTCOMINGS BEEN DISCUSSED WITH THIS EMPLOYE? .....

..... IF YES, PLEASE EXPLAIN

WHAT IS YOUR OPINION OF THIS EMPLOYE'S CHANCE OF SUCCESS ON THIS JOB

SUPERVISOR ..... DATE: ..... NOTED: .....

Fig. 7. This rating form is sent out by Employment Department as a follow-up after the graduate has been placed. Other side of sheet provides for making 2nd and 3rd reports

copies are sent to the Technical Engineer at each power plant.

Some graduates working in a productive engineering capacity following departmental training may need further company development. An opportunity is offered these engineers for this training in the last stage of the program. They are loaned to specific departments closely associated with their jobs for three to six months of training.

During the graduate's first year of departmental training, his progress is followed up very closely by the employment department, to measure the success of permanent placement. A follow-up form is sent to the department at the end of 3½ months, 5 months, and one year, and becomes a permanent part of the graduate's record. Factors considered on the follow-up form are as follows: (1) quality and quantity of work, (2) attitude toward the work, (3) ability to coöperate and get along with fellow employes, (4) appearance and (5) punctuality and general physical condition. Thereafter, the department normally appraises the graduate's work performance at least yearly.

This development program for engineers has additional features such as an orientation program in which all graduates participate after they have been with the company at least one year.

This Orientation Group meets one day a week from September to December. These weekly meetings include talks, visual aids and field trips as the various department representatives discuss what goes on in their departments. This program gives the graduate an opportunity to learn how the work of the various departments is performed, interrelated, and coördinated throughout the company.

The company also sponsors an eight-month course in which engineers meet two hours each week to bridge the academic approach and the practical engineering aspects of the power utility business. Emphasis is placed upon the engineering aspects and also the economic problems involved. This course was set up and is under the direction of a local university professor. The general presentation is given by the professor followed by a discussion period led by company personnel. A set of notes is the official text and numerous references to standard textbooks and the general engineering literature are provided. Illustrative problems are assigned for student work.

The training and development program for engineers is coördinated by a technical representative in each department. However, every supervisor must share the responsibility of evaluating and training these young engineering graduates. THE END

CONSTRUCTION NEWS

Anchorage, Alaska — Chugach Electric Association has approved plans for installation of high-voltage transmission lines in conjunction with construction of Cooper Lake hydroelectric project now under construction on the Kenai Peninsula. Construction and installations will be performed under supervision of North Pacific Consultants, Portland, Ore. Transmission line will represent an investment of $12,500,000 when completed late in 1959.

Los Angeles, Calif. — Southern California Edison Co, 601 W Fifth St, has announced the purchase of two water wheel generators from the Westinghouse Electric Corp, Pittsburgh, Penna., at a cost of approximately $2,000,000. The machines, each rated at 64,600 kw will be installed at company's Mammoth Pool hydroelectric generating station, now under construction on the San Joaquin River, about 50 miles northeast of Fresno, Calif.

Greenwich, Conn. — The Atomic Energy Commission has negotiations under way with AMF Atomics of Greenwich, Conn., for a nuclear training and research reactor to be erected in Puerto Rico. Contract, still in its final stage of negotiation, calls for a $1,050,000 payment by the AEC to AMF Atomics, a division of American Machine & Foundry Co, 261 Madison Ave, New York, N. Y. New facility will be used at the AEC's nuclear center on the island. The reactor, scheduled for completion by the summer of 1960, will contain features permitting future operation at levels up to 5000 kw of heat, although initial capacity will be 1000 kw.

Orlando, Fla. — City Utilities Commission, 102 Wall St, has engaged Thompson & Street Co, Charlotte, N. C., to prepare plans for expansion of city's municipal steam power plant, here. Work will include installation of new main plant building to house new turbine generator, high-pressure boiler and auxiliary equipment. Proposed to begin work soon for completion by early 1960. Cost of plant and additional generating capacity reported to be about $4,347,400, when completed.

Chicago, Ill. — Commonwealth Edison Co, 72 W Adams St, has announced that the Dresden nuclear power station now under construction at an estimated cost of $45,000,000, will be ready for operation by the summer of 1960. The equator ring of the 190-ft. diam Hortonsphere has recently been completed and tested. The huge steel sphere, to enclose 3.6 million cu ft of space, will house the atomic reactor, the nation's largest nuclear power reactor to date. Dresden Station will have an initial capacity of 180,000 kw and when completed, will feed into company's power grid and interconnected transmission systems serving this area.

Hill City, Kan. — Central Kansas Power Co, 300 N Cedar St, Abilene, Kan., has plans under way for the construction of new power plant near here. Company's Hays Division will construct a new steam-electric generating station which will have an initial capacity of 22,000 kw which in turn will be leased for a long period of time by the Sunflower Electric Coöperative, Wakeeney, Kan., which will operate the new facility. Work will get under way at once for scheduled completion in 1960. Cost of installation reported to be $5,675,000 when completed.

Salem Harbor, Mass. — New England Electric System, 441 Stuart St, Boston, Mass, has announced completion of major addition to generating capacity of local power station. A new generating unit with a capacity of 140,000 kw was placed on line in mid-summer bringing total capacity of station to 300,000 kw. Company announced that they are now thinking in terms of larger generating units with a capacity of 200,000 kw or more, larger than any existing installations in the company system at the present time. To provide for such future installations, company has secured tidewater plant sites in Quincy and Somerset, Mass, and North Kingstown, R. I.

Grand Haven, Mich. — City of Grand Haven, Board of Public Works, has approved plans for extensions and improvements in municipal power plant, work to include installation of new steam-electric generating unit on an island in the Grand River. Construction program will get under way as soon as preliminary engineering is completed. Cost to be in excess of $4,800,000.

Fergus Falls, Minn. — Otter Tail Power Co, 125 Mill St, South, this city, has announced plans for expansion of steam-electric generating station at Hoot Lake Station. Installation will include a new 53,000 kw turbine generator unit, high pressure boilers and auxiliary equipment. Work is currently under way on new installation which is scheduled to be placed in line early in 1960. Total cost of local plant expansion when completed reported to be in excess of $12,000,000.

St. Louis, Mo. — Chevrolet-St. Louis Division of General Motors Corp, 3809 Union Blvd, has authorized plans for the expansion of company power house at this location. Project will comprise a 3-story brick, steel and concrete addition to main power house measuring approximately 40 ft by 100 ft. Work is already under way on the new addition with completion scheduled for early 1959. J. S. Alberici Construction Co, this city, has been awarded the construction contract reported to be about $250,000.

Trenton, N. J. — Public Service Electric & Gas Co, 80 Park Pl, Newark, N. J., has announced contract award to the United Engineers Constructors, Philadelphia, Penna., for the construction of new power plant and required dredging at company's new Mercer Generating Station, now under way, on Duck Island, Hamilton Township, just south of this city. Work will include installation of a large steam-electric generating unit with an initial capacity of 320,000 kw, with provision for installation of another unit at a later date. Project now under way, scheduled for completion in 1960, will represent an expenditure of more than $72,500,000.

New York, N. Y. — Consolidated Edison Co, Inc, 4 Irving Pl, has made an offer to the City of New York for the purchase of three power plants located at 59th St and the Hudson River; 74th St and the East River and Kent Ave, and Division St, Brooklyn, N. Y. The utility offered to pay the city $82,000,000 in cash and to assume full responsibility for $41,000,000 worth of plant improvements for a total of $123,000,000. The city, in turn, would pay Consolidated Edison $20,000,000 a year for power to run the IRT and BMT subway divisions. Company hopes to take possession, operation and control of the three plants by September 1958 and to acquire legal title to the plants by September 1961.

Stillwater, Okla. — Electric Light & Power Dept, plans expansion and improvement in municipal steam-electric generating station, with installation of turbine generator unit, steam generator and auxiliary equipment, for increased capacity. Cost reported close to $2,150,000. G. H. Guernsey & Co, Oklahoma City, Okla, consulting engineers. Work will begin as soon as plans are completed for scheduled completion in 1960.

Dallas, Tex. — Texas Utilities Co, Gulf States Bldg, has announced a change in construction schedules beyond 1959 because of a slower rate of growth in the area which company serves. As previously announced in these columns, one of the steam-electric generating units with a capacity of 240,000 kw, originally scheduled to be on line in 1960, is now scheduled to go into operation late in 1961. Company is now completing three generating installations with a total capacity of 408,000 kw which will go on line this year and has work progressing on two units with a capacity of 375,000 kw which will be completed by the summer of 1959. This change and related revisions in transmission plans will result in a total construction cost of $76,000,000 for 1958.

Spokane, Wash. — Washington Water Power Co, 825 Trent Ave, has announced plans for the construction of a 48-mile, 230,000-v transmission line from Noxon Rapids to Pine Creek. Company has issued contract award to the Russell Oliver Co, Sandpoint, Idaho, for construction of the new line which will get under way at once. Cost of new installation reported to be approximately $1,390,000. Work to be completed in mid-1959.

Power Engineering handbook

Steam Pressure Important in Using Unit Heaters

By JOHN D. CONSTANCE

UNIT HEATER catalog ratings are based on an entering air temperature of 60 F and 2 psig steam pressure. When other than this standard is encountered, the Btu output of the unit heater will change and may be corrected according to the set of curves in Fig. 1. The effect of these variable steam pressures and entering air may be readily appreciated from the chart. The chart is based on a constant fan speed or air flow at free delivery. Resulting multiplier is correct within 5 per cent.

When unit heaters of the horizontal throw type are operated with higher than rating steam pressures, the leaving air temperatures are higher than rated conditions. Good design dictates a leaving air temperature to be not in excess of from 50 to 60 F of the room design temperature. With room air entering at 60 F, the final leaving temperature should be from 110 to 120 F.

Cold air of greater density falls naturally to lower levels, replacing warmer air that may be present. Thus if cold air is removed from the floor and warm air is allowed to take its place, the best general over-all results, both from comfort and economy, will be obtained. A look at the chart will tell us that the Btu output of a unit heater increases with lowering inlet temperatures. Therefore, per dollar expended, greater Btu output and minimum power consumption result.

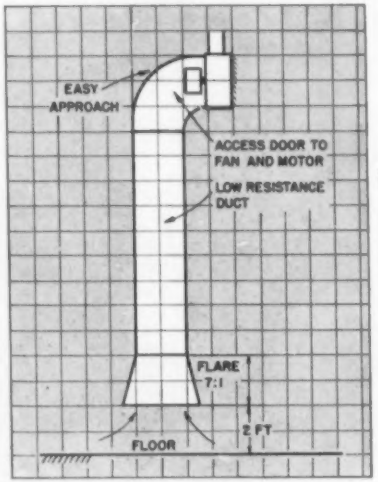
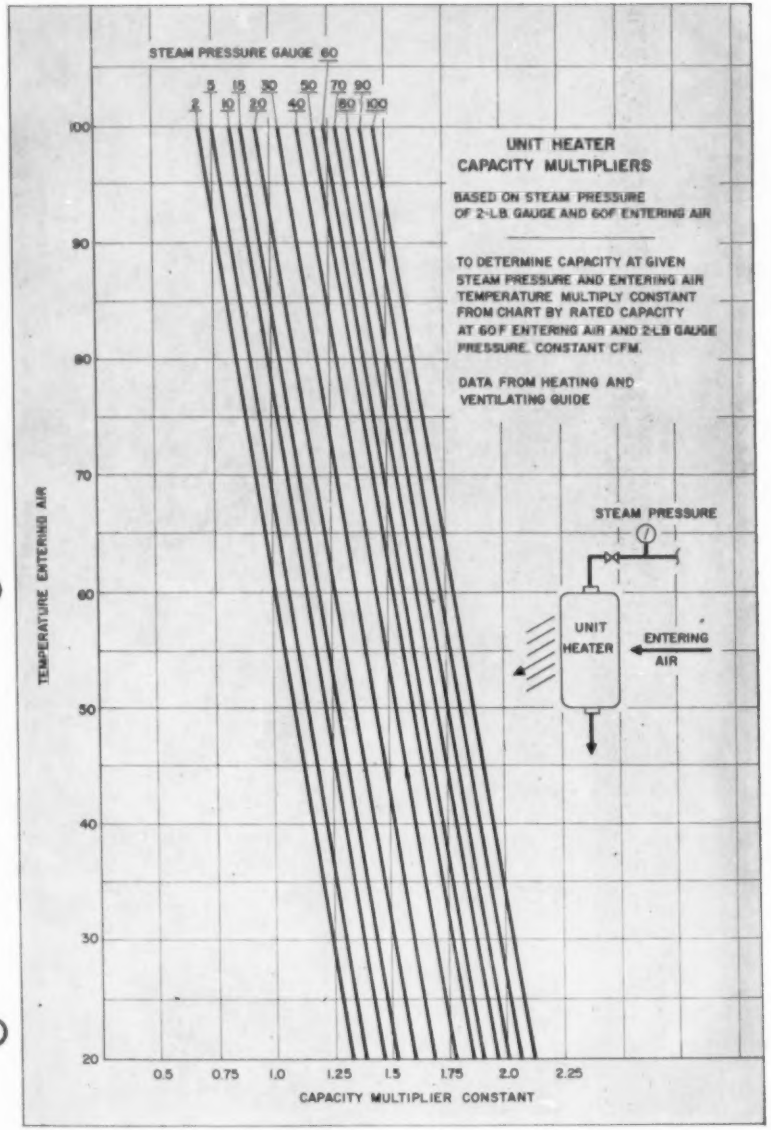


Fig. 2. One way to correct effect of high-mounted heater is to attach suction duct to heater inlet. Duct takes cold air from floor, lowers warm air

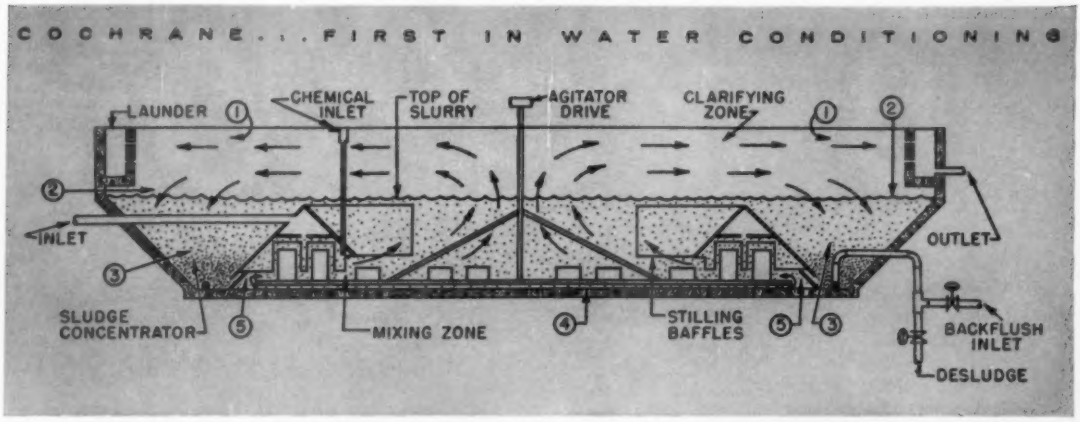
So that the hot air will reach the floor line, care must be taken to check outlet temperature. This should not be greater than the 120 F just mentioned, since the

Fig. 1. Chart (opposite) corrects Btu output of unit heaters when other than 60 F entering air temperature and 2 psig steam conditions are present. Chart is based on constant fan speed or flow at free delivery

fold along this line—outside edges toward you



cut along this line



A **Cochrane** solids contact reactor is designed to provide the ultimate in clarification

Cochrane suspended solids contact coagulating and softening clarifiers are packaged units that combine a mixing zone at the bottom with a clarifying zone above.

A bottom agitator in the mixing zone keeps old precipitates in constant suspension. Thorough mixing and contact between the old and new precipitates is thus assured. This results in a more complete reaction with a minimum in chemical requirements and retention time. In the clarifying zone the water is effectively separated from the slurry precipitates and clarified.

The Cochrane reactor design is unique in its baffle and agitator arrangement, as follows:

① Radial *Horizontal* Flow—*Not Upflow*. Velocity decreases from center to launder. Slurry particles separate more efficiently from horizontal flow than from upflow.

② Slurry flow is *downflow* in clarifying zone below collecting launders—*not upflow*—thus preventing carryover of turbidity into effluent.

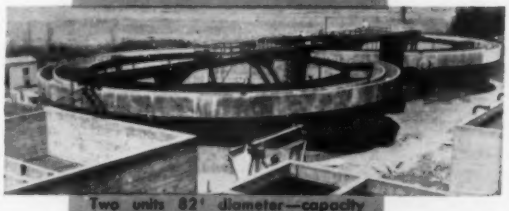
③ Sludge settles only in annular *concentrator* outside of mixing zone. Maximum concentration results because no turbulence is present. This feature saves wastage of water in desludging.

④ There is no premature loss of slurry strength in mixing zone because no sludge settles on the floor of mixing zone.

⑤ Turbulence in mixing zone assures excellent mixing. A large, full-diameter agitator causes centrifugal outward flow, against the diverting baffle in front of the outer port and turns flow inwardly towards central port.

72' diameter, capacity 9,000,000 GPD located in Georgia.

72' diameter, capacity 9,000,000 GPD located in Texas.



Two units 82' diameter—capacity 20,000,000 GPD located in Washington.

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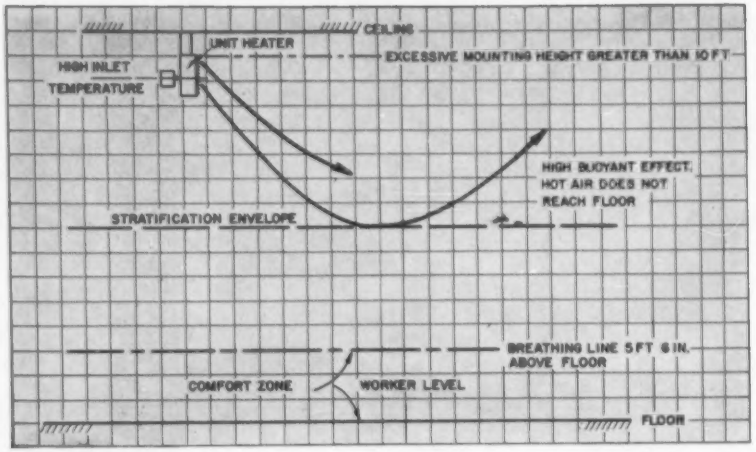


Fig. 3. Heated air is extremely buoyant and stratification sets in when heater is mounted above 10 ft

higher the temperature the greater the tendency for the heated air to rise and pocket in the upper levels. Units supplied with higher steam pressures than rated should be selected for reduced condenser surface.

Mounting heights must be watched and manufacturer's recommendations followed. Horizontal discharge units placed high (above 10 ft) will operate at reduced capacity and attendant discomfort at the floor line (see Fig. 3).

To alleviate this condition, lower unit heater level to recommended height *or* attach suction duct to heater inlet (see Fig. 2). This will permit the fan to draw in cooler air (see Fig. 1), force warmer air to take its place and improve conditions at comfort zone. However, because of added friction (not free delivery now) air handling capacity will reduce Btu capacity and increase outlet air temperature. Optimum duct friction must be checked with heater manufacturer.

Watch That Nitrogen!

By PAUL C. ZIEMKE

A GROUP of new, 110-kva transformers had been received from the manufacturer. As is modern practice, these were protected against infiltration of moisture by injecting nitrogen under 5-lb pressure. One of the units was opened top and bottom to vent the gas on arrival. After a short interval a workman entered to remove blocking. Later, a second man looked in and saw that the first man appeared to be unconscious.

The second man called for help and proceeded at once to carry the victim up the ladder to fresh air, where other workers began artificial respiration. Breathing was restored and an ambulance was used to transport the man to the hospital. En route he went completely berserk and required four men to hold him down. He was hospitalized two days.

This occurrence emphasizes the need for adequate ventilating of nitrogen-filled transformers before men are permitted to enter. This can be done by a jet of compressed air, by large fan, or by the use of air turbine (Lamb air-mover).

If there is great urgency, the man should be protected by wearing an air supply respirator.

fold along this line—outside edges toward you

Patch was of suitable dimensions to include blowdown opening. Note neatness of the fit to the cut-out

Fusion Welding Speeds HRT Boiler Repair

By K. D. CILLEY *

ADVENT of the general acceptability of fusion welding in unstayed areas subject to the products of combustion, made the repair of this all-riveted, 90-in. boiler considerably more simple, and the job was done with much less loss of time and production than would have been the case otherwise.

Cause behind the need for repair was failure of the human element in maintaining the rear hand-hole plate free of leakage past the gasketed joint.

As the leakage persisted over a period of years, the flange of the blow-down pad became considerably reduced and finally was considered unsafe for further service. When the pad was removed for replacement, it was noted that the shell plate had also become wasted, as determined by the abrupt change of plate thickness under the pad as compared with that adjacent to the pad.

Plate reduction on either side was $\frac{1}{4}$ in., while between the pad and calking edge of the shell, the thickness was reduced by $\frac{3}{16}$-in. from the original of $\frac{9}{16}$-in.

This raised the immediate question of a repair or a substantial reduction in operating pressure to promote safety. Patching was decided on, in compliance with the National Board rules for repair, and State permission was granted for the installation by fusion welding.

Appearance of the patch after welding is shown in the photograph. Riveting, calking, hydrostatic testing all added up to a neat, inexpensive and safe repair job which returned the boiler to service at its original operating pressure.

The photograph clearly shows the patch to be of suitable dimensions to include the blow-down opening.

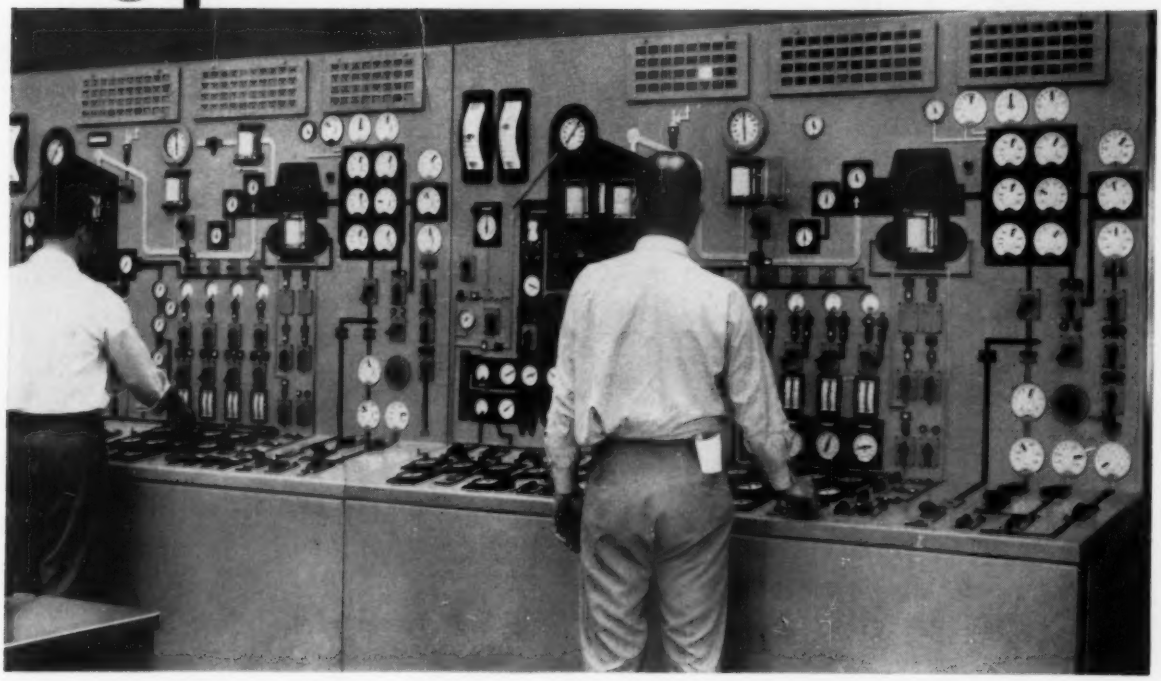
Double butt welding of the patch to the parent plate was accomplished by the electric arc method, followed by stress relief. Joint was then radiographed to prove soundness.

It may be noted that the blow-down pad as well as the rear head to shell seam was riveted, as in the original construction, both being accomplished following the welding and stress relieving.

* Staff Engineer, Mutual Boiler & Machinery Insurance Co

cut along this line

How Copes-Vulcan control systems boost power plant efficiency



Copes-Vulcan puts combustion control at operator's finger tips

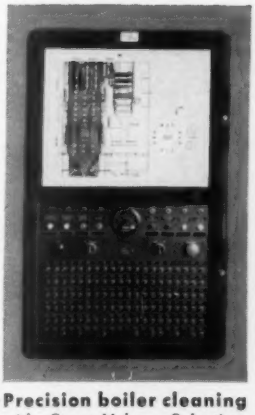
Equipped with easy-to-read recorders and control stations, this compact Copes-Vulcan panel centralizes operator control and simplifies boiler operation. This modern system features circuit simplicity with independent control loops on air flow, fuel loading and furnace draft. Drive units assure accurate positioning and fast response, and eliminate the need for interconnecting control loops.

A custom installation . . . a continuing service

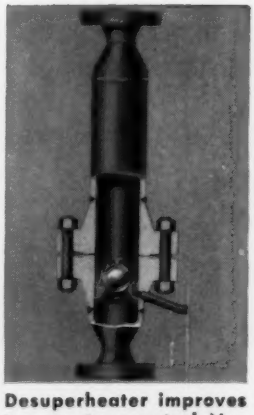
Copes-Vulcan Combustion Control is just part of an integrated boiler control system for regulating feed water, boiler steam temperature and boiler cleaning.

Whether furnished in individual units or integrated into a single system, each installation is tailored to meet specific requirements of generating capacity, load range and fuel. Copes-Vulcan supplies skilled service, when needed, for the life of the installation.

Write for Bulletin 1032 showing a Copes-Vulcan control system working at a showcase generating plant.



Precision boiler cleaning with Copes-Vulcan Selective-Sequence or Automatic-Sequential soot blowing systems. Space-saving panel permits easy monitoring, flexible programing . . . assures thorough cleaning with less steam and/or air. Write for Bulletin 1029.



Desuperheater improves temperature control. New Variable-Orifice Desuperheater* holds reduced steam temperature constant only 20° downstream from desuperheater outlet, even over a 50-to-1 load range. Write for Bulletin 1037. *Patent applied for

Copes-Vulcan Division
BLAW-KNOX COMPANY
Erie 4, Pennsylvania

For more data circle 544 on Post Card

Introduction to Steam Power

5—Heat Transmission

Fifth installment in this series of articles on fundamentals of power plant engineering. Authored by engineers at Commonwealth Edison Co in Chicago

1. In order to change the heat energy liberated by burning of fuel into a condition where it can be used for the generation of electricity it is necessary to absorb it into the working medium.
2. The processes of accomplishing the exchanges are those of heat transfer.
3. The prime condition required to have heat transferred is a *temperature difference.*
   a. The flow of heat is from the body of higher temperature to that of lower temperature; that is, from the hot body to the cold.

Methods of Heat Transfer

1. Radiation
   a. Most common form of radiant energy is heat from the sun.
   b. Radiant heat passes through dry gases or transparent solids or liquids without heating them to any appreciable extent.
   c. Air containing dust and water vapor will intercept and absorb radiant heat. Thus the earth's atmosphere is warmed by heat from the sun.
   d. Radiant heat, like light, is reflected from various metals.
   e. Polished surface reflects heat; a black surface absorbs it.
   f. Radiant heat will pass through transparent solid substances, such as rock salt crystals without heating them.
   g. Blast of heat that is emitted when a furnace door is opened is radiant heat.
   h. Radiant heat is in the form of wave motion. Heat waves travel at enormous speeds along straight lines in all directions from the source.

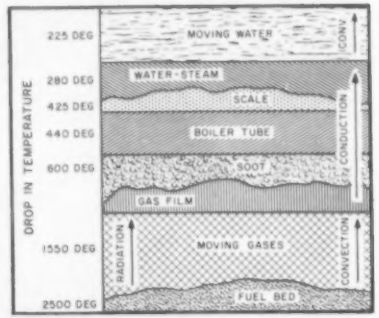


Fig. 1. In a boiler furnace, heat transfer takes place by radiation, convection and conduction

   i. Radiant heat waves may be concentrated with a lens.
   j. Radiation is one method by which the heat of the fuel bed is transmitted to boiler tubes.
2. Convection
   a. Another familiar method of heat transfer is that of convection — the transfer of heat by the flow of currents within a *fluid* body. 1. Warm air home heating utilizes the principle of convection. The currents of warm air arising from the steam and hot water radiators are convection currents. 2. Ventilating systems, chimneys, and stacks also depend upon this principle. 3. The movement within a pan of water that is being heated at the bottom is due to convection currents set up within the water.
   b. In this process a portion of the fluid becomes heated, and the density of that portion diminishes. Since the weight for a given volume is less, it rises and is displaced by the cooler, more dense surrounding portions of the liquid.
   c. This is an important method of heat transfer within the steam boiler and furnace. 1. By this method, the hot gases arise from the fuel bed and pass through the tubes of the boiler. It eventually carries the gases up the stack. 2. Convection currents are set up within the water in the boiler tubes, thus distributing the heat uniformly.
3. Conduction
   a. Transfer of heat by the molecules of a substance. 1. When one end of a metal rod is heated, the opposite end also becomes warm. 2. The heat travels from one particle of metal to the next. 3. Heat will flow between two

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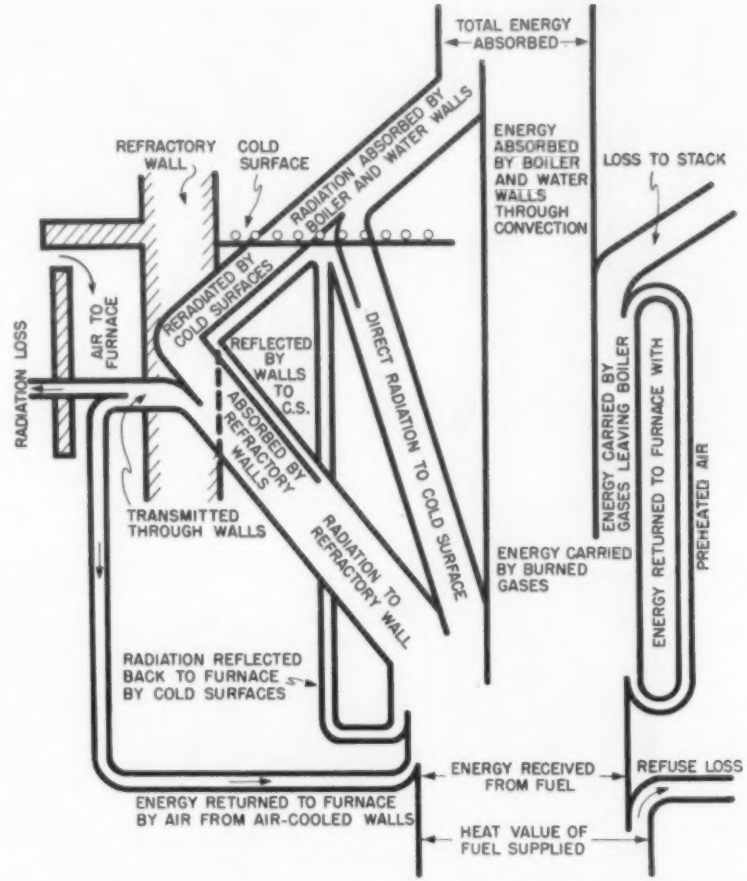
TOTAL ENERGY ABSORBED
REFRACTORY WALL
COLD SURFACE
RADIATION ABSORBED BY BOILER AND WATER WALLS
ENERGY ABSORBED BY BOILER AND WATER WALLS THROUGH CONVECTION
LOSS TO STACK
RADIATION LOSS
AIR TO FURNACE
REFLECTED BY WALLS TO C.S.
REABSORBED BY COLD SURFACES
DIRECT RADIATION TO COLD SURFACE
ABSORBED BY REFRACTORY WALLS
TRANSMITTED THROUGH WALLS
RADIATION TO REFRACTORY WALL
ENERGY CARRIED BY BURNED GASES
ENERGY CARRIED BY GASES LEAVING BOILER
ENERGY RETURNED TO FURNACE WITH PREHEATED AIR
RADIATION REFLECTED BACK TO FURNACE BY COLD SURFACES
ENERGY RECEIVED FROM FUEL
REFUSE LOSS
ENERGY RETURNED TO FURNACE BY AIR FROM AIR-COOLED WALLS
HEAT VALUE OF FUEL SUPPLIED

Fig. 2. Schematic picture of the energy streams in a furnace. Prime condition is temperature difference

fold along this line—outside edges toward you

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To eliminate forever potential body-bonnet leaks, Vogt engineers have developed these new General Purpose valves with seal welded bonnet joints.

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Available NOW in both gate and globe types, ¼" thru 2", and in both socket weld and screw ends. These are priced identical to the bolted bonnet GP valves; gate valves the same as Series 12111 and globe valves the same as Series 12141.

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sections of a material only when there is a difference in temperature. 4. Rate of heat transfer by conduction varies: directly as the temperature difference; directly as the thermal conductivity; directly as the area of the transmitting surface; inversely as the thickness of the transmitting substance.

b. Metals vary in their ability to conduct heat; a good conductor permits a rapid flow.

c. This is an important method of heat transfer in the steam power plant. 1. Boilers must be built of material that has strength to hold high pressures. 2. Steel is used for boiler tubes, as it has strength as well as being a good conductor. 3. Tubes of a surface condenser are made of copper alloy, for rapid heat transfer.

4. Heat transfer by a combination

a. In most heating situations a combination of methods of heat transfer is involved. In a boiler furnace all three methods are utilized.

b. Transmission of heat through a boiler tube. 1. Heat is transmitted by radiation and convection to the stationary gas film that lies next to the soot on the tube. This film is called the dry surface and is the point where heat ceases to travel by convection and starts to travel by conduction. 2. The heat must travel by conduction, through the soot, through the metal of the boiler tube, and the scale within the tube. The presence of both the soot and scale slow up the process of heat transfer and cause a major problem in the power plant, as they are both poor conductors of heat. The thin layer of steam and water that lies next to the scale, called the wet surface, is the point where the heat ceases to travel by conduction and starts to travel by convection.

Heat Transmission in Materials

1. Cases of heat transmission that occur most frequently in engineering work:

a. Hot fluid at constant temperature. A hot fluid at a constant temperature surrenders heat to a flowing cold fluid whose temperature is increased. 1. Surface condensers, feedwater heaters.

b. Cold fluid at a constant temperature. A fluid at constant temperature receives heat from a hotter flowing fluid whose temperature decreases. 1. The steam boiler.

c. Parallel flow. Hot and cold fluids flow in the same direction, their temperature converging nearer to equality as they progress.

d. Counter flow. The hot and cold fluids flow in opposite directions, the exit temperature of each fluid approaching the entering temperature of the other as they proceed.

2. Mean Temperature Difference

a. Before heat transfer can be analyzed mathematically it is necessary to find the true value of the mean temperature difference.

b. The rate of heat transmission depends upon the temperature difference between the two fluids. 1. The transfer of heat causes the temperature of the two fluids to approach equality. 2. As the temperature difference becomes less, the two fluid temperatures converge less rapidly.

Heat Insulation

1. Refractories

a. Desirable properties: relative infusibility; relatively high thermal resistance; flexibility of structure; low thermal expansion; impermeability toward gases and liquids; chemical inertness; resistance to abrasion.

b. Fireclay: most commonly used in making refractories. It is composed of silica and alumina. These react to form complex compounds when heated to high temperature. The raw clay fuses at 2900 F–3200 F. The compound fuses at a slightly lower temperature.

c. Silicon Carbide: 1. A material which when bound together will form a refractory material. 2. Bonded — mixed with plastic clay which binds the mass after heating. 3. Recrystallized — pressed together with small amount of organic binder. It is burned at a temperature sufficient to cause the formation of entirely new crystal structure.

2. Insulating Materials

a. Essential requirement of high temperature insulators: low conductivity, mechanical strength, low shrinkage when heated, resistance to the decomposing effect of high temperatures, resistance to effect of moisture, light weight.

b. Asbestos Fiber: retains its physical strength until water of crystallization is driven off; is mixed with magnesia or infusorial earth to form product to be used for high temperatures.

c. Diatomaceous Earth: 1. Composed of pure silica. Although the organic matter has entirely disappeared, the microscopic cells remain. 2. It is mixed with asbestos fiber for strength.

3. Kaolin

1. Used for refractory insulators.
2. Pure kaolin fuses at 3245 F. Products made from it are good up to 3000 F.
3. Its porous structure develops during manufacture.
4. Has low thermal conductivity.

Thermal Conductivities

Following are the approximate thermal conductivities of several common substances in Btu per hour, per sq ft of area, per ft of thickness, per degree F temperature difference.

Silver	240*
Copper	220
Gold	170
Aluminum	116
Brass	65
Wrought Iron	35
Cast Iron	27
Steel	26
Magnesia Brick	1.5
Firebrick	0.7
Alumina Brick	0.5
Asbestos	0.1
Infusorial Earth	0.05
Cork	0.03
Mineral Wool	0.03
Felt	0.02
Air (still)	0.01

* Values are only approximate

POWER ENGINEERING HANDBOOK

Solutions for Plating of Tin and Lead

NEW PLATING solutions have been developed to allow tin and lead to be plated singly, or in combination, in any proportion of value to the user. High-lead-content alloys (93 per cent) are suitable for bearing applications; 60–40 tin-lead alloys are ideal for components requiring subsequent soldering. These and any intermediate percentages for special purposes are readily achieved merely by mixing the solutions in proper volumetric proportions.

Both the new "Dalic" plating solutions are slightly alkaline, the tin having a pH of about 7.5, the lead ranging between 8.0 and 8.5. It is reported that these solutions will not set up corrosion cells, will not cause embrittlement, and do not attack different neighboring metals.

The tin and lead electrolytes were designed specifically for use with the manufacturer's selective area plating equipment. Higher current densities are possible than in conventional plating baths so that, combined with the continuous agitation inherent in the Dalic process, a much denser deposit is achieved.

The Dalic process is easy to use. A special rectifier transforms 220-v a-c into d-c, a stepless voltage-control permitting the selection of any voltage from 0 to 35. Most plating is carried on at about 8 to 20 v.

Electric current is sent through the part to be plated by means of a cathode lead, clamped to the part, and the stylus which applies the electrolyte. The stylus includes a high-purity graphite anode, wrapped in cotton and saturated in the plating solution. Any metal may be plated on almost any other, simply by choosing the proper electrolyte. Surfaces up to 2 sq ft are normally the limit for this process, because it is intended primarily for smaller areas. However, larger units may be plated in prototype work.

The Dalic process makes it possible to plate partial areas without excessive masking or stopping-off. The equipment is mobile, and often work can be handled in place, without dismantling and subsequent reassembly. Almost any metal from bismuth to zinc may be deposited.

For further information, write The Editor, POWER ENGINEERING.

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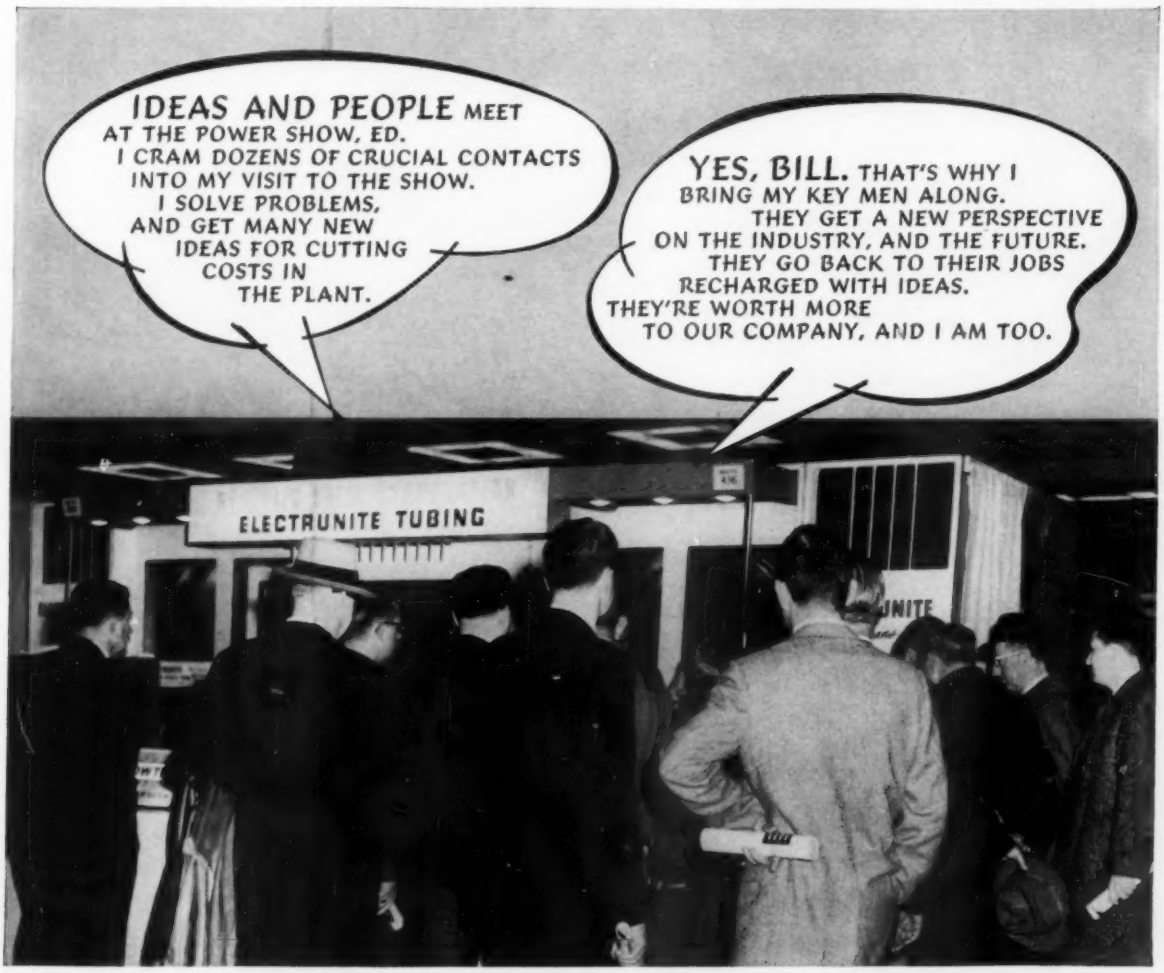
IDEAS AND PEOPLE MEET AT THE POWER SHOW, ED. I CRAM DOZENS OF CRUCIAL CONTACTS INTO MY VISIT TO THE SHOW. I SOLVE PROBLEMS, AND GET MANY NEW IDEAS FOR CUTTING COSTS IN THE PLANT.
YES, BILL. THAT'S WHY I BRING MY KEY MEN ALONG. THEY GET A NEW PERSPECTIVE ON THE INDUSTRY, AND THE FUTURE. THEY GO BACK TO THEIR JOBS RECHARGED WITH IDEAS. THEY'RE WORTH MORE TO OUR COMPANY, AND I AM TOO.
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EQUIPMENT NEWS

Described on these pages are new and improved products. Use Reader Service Cards on pages 121–122 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

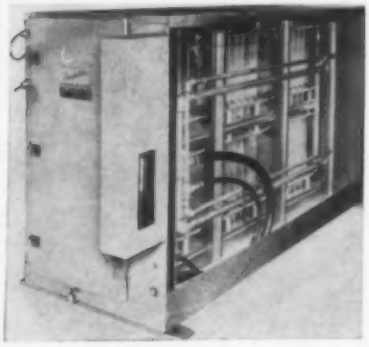
1 — TEMPERATURE PROBE records furnace conditions

This traversing temperature probe makes possible a continuous record of furnace temperature conditions during boiler start-up. It travels back and forth through critical superheater or other furnace passes to indicate or record temperatures while registering its position to guide the operator in his firing procedure, giving a constant check on potential "hot spots" during the lighting-off period. An adaptation of a retractable soot blower, the probe consists of a thermocouple on the end of the lance. Unlike the soot blower, however, the lance does not rotate in travel. The Chromel-Alumel thermocouple is suitable for temperatures to 2200 F and protective tips are available for either 1600 F or the higher temperature. For temperatures above 1000 F the lance is air cooled.

Traversing speed of the probe is 6 fpm, with a 1-sec lag between probe position and corresponding temperature of the thermocouple. (With a multiple point temperature recorder an additional delay would be introduced.) When used with a two-pen recorder, one pen registers temperature and the other, probe position. The complete temperature probe, in lengths to 30 ft, comes equipped with electric drive motor. Necessary controls are also provided. Copes-Vulcan Div., Blaw-Knox Co.

2 — ELECTRONIC AIR CLEANERS feature automatic operation

Model PG Precipitrons are electronic air cleaners with fully automatic operation available in sizes for requirements from 1920 to 28,800 cfm. These units are described as especially suited for commercial plants. Washing and adhesive application is automatic. In operation, a motorized traverse washer flushes out collected dirt from the metal collector plates and sprays on a new coating of cold water adhesive. A push-button sequencing controller performs the entire cycle of stopping the fan, completing the washing cycle and returning the system to normal. For fully automatic maintenance, an optional clock control is available which operates the sequencing controller on a predetermined schedule for washing at regular intervals.



The new units incorporate major advantages of manually operated Models PA and PF, it is announced — high capacity with low over-all space requirements and high air cleaning efficiency. The new Model PG Precipitrons are packaged-type units matching dimensions of company's air-distributing units, coils and accessories and are designed for easy in-line installation. Sturtevant Div., Westinghouse Electric Corp.

3 — CHEMICAL PUMPS permit continuous wet, dry operation

These small chemical pumps with carbon gears and bearings are suitable for continuous wet or dry operation in corrosive chemical service. Self-priming and self-lubricating, pumps are available for immediate shipment in 3 and 10 gpm capacities. The carbon bearings are recommended for temperatures to 450 F and speeds to 1800 rpm. Pumps are available in a wide variety of materials, including 316 and Type 20 stainless steel, nickel and Hastelloy. Pumps are suggested for use in intermittent pumping of corrosive or hazardous fluid. Eco Engineering Co.

4 — COMPOUND protects coal, bulk materials stored outdoors

Compound SP is formulated to blanket and protect outdoor storage piles of bulk materials against losses from wind or rain erosion. The spray-applied solution contains additives for maximum coverage and penetration. Compound SP is described as a blend of synthetic, organic, long chain polymers in a water base that forms a thin crust which is tough, durable and resistant to weathering. In a series of heavier concentrations adaptable to a wide range of material composition, particle size and climatic conditions, they are suitable for coating stock piles of Bauxite, carbon, coal, sulfur and many other types of materials. Protection is said to last for periods in excess of a year.

Compound SP is described as inert, unreactive and non-toxic without adverse effect on burning qualities of coal or subsequent processing of sulfur, metal ores etc. The solution is supplied in various grades for spraying. A color indicator can be included at no extra cost to show where treatment has been made. Johnson-March Corp.

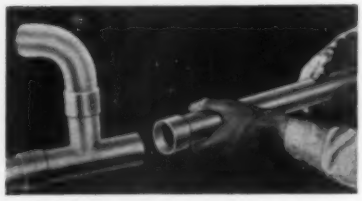
5 — PIPE COUPLERS for use with pressure joint pipe

This single unit pipe coupling machine is designed for cement-asbestos, concrete, clay or cast iron pressure joint

pipe. The compound leverage coupler saves time as well as labor, it is said, and pulls pipe all the way home for a positive seal. Unit rests on top of pipe and is clamped in position with a single action lever. Couplers are furnished in six sizes, 6 to 16 in. The E. H. Wachs Co.

6 — CONNECTOR simplifies piping system assembly

Brazed or welded connection of stainless piping systems are said to be completed more easily with a stainless aligning connector that fits over the ends of pipe or

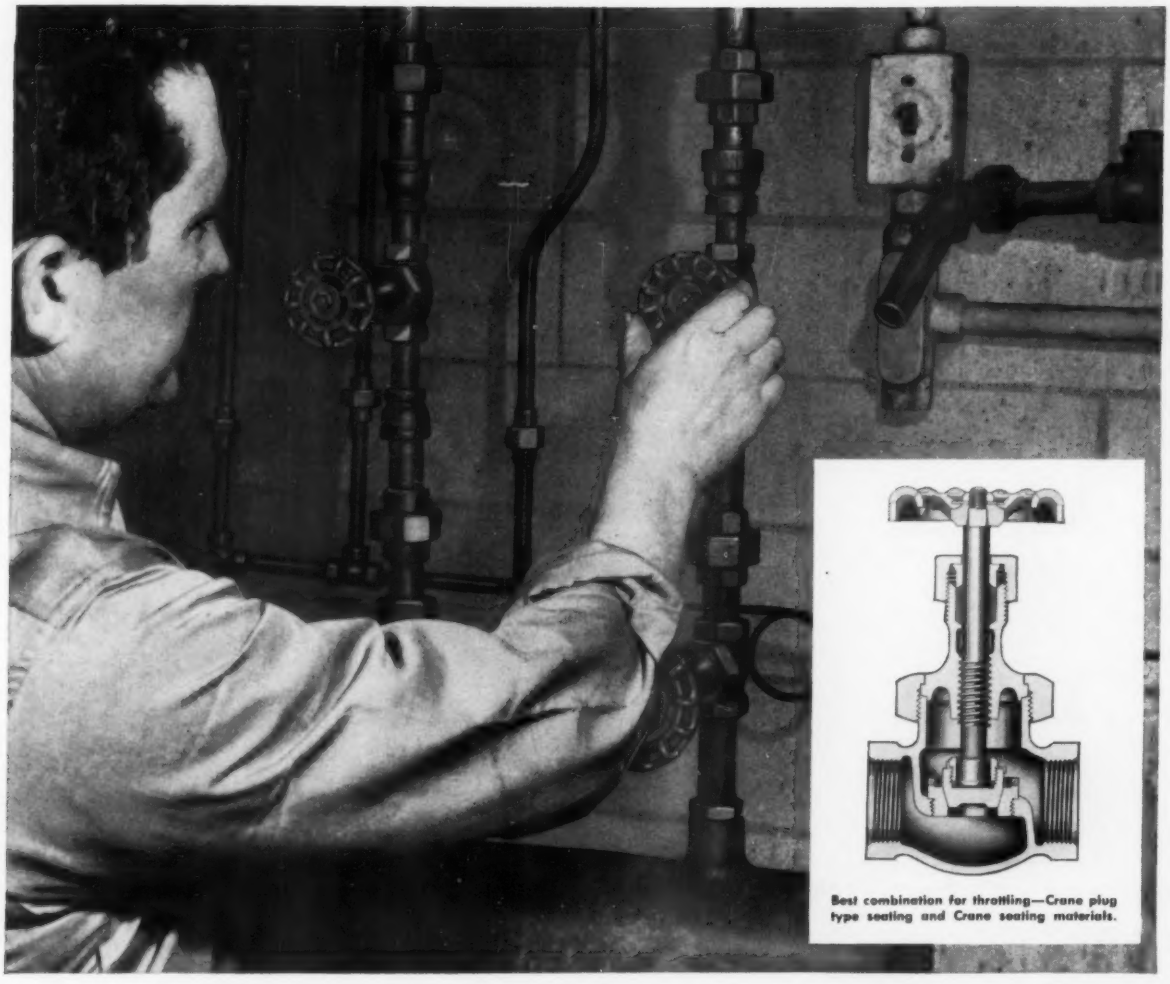


fittings to provide a socket-type joint. The connector provides a snug fit to hold pipe and fittings in position until welding or brazing secures the connection. It also permits in-place preassembly of complicated process piping layouts. Designed to be used with company's Speedline fittings and lightwall piping systems, Schedules 5 and 10, this connector fits over fittings and pipe. Speedline Div., Horace T. Potts Co.

7 — PIPE CUTTER requires no vise or turning

This pipe cutter is designed for standard or extra-heavy soil pipe, field tile, vitreous tile, flue lines (square or round),

Transite, and Duriron. Pipe cutter is described as easy to use, requiring no vise or turning. Operator wraps the



Best combination for throttling—Crane plug type seating and Crane seating materials.

Surprising savings for this power plant with Crane bronze throttling valves

At least once a year, this power plant of a leading machine tool builder was replacing the valves in the ½-inch continuous blowdown lines on its 60,000-pound boiler.

They were high-priced valves, but they couldn't take the continual throttling service. The seats cut out rapidly . . . blowdown regulation was lost . . . valve costs kept rising.

Thirty-one months ago this plant replaced the short-lived valves with Crane No. 212P, 200-pound bronze globe valves with plug type disc. Most of the time these Crane valves have been operating at less than half-open.

Yet, at every inspection to date, they've been found O.K.—no seat damage . . . no loss of regulation . . . no maintenance needed. Another proof of the economy of Crane quality!

To cut your valve and piping maintenance costs—on steam or any fluid—call in your local Crane Man. He has more to offer in money-saving piping materials.

COST-SAVING IDEAS FOR YOU in this free 36-page book of "Valve Performance Facts." Get your copy from your Crane Man or write to address below.

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chain around the pipe, pulls the handle, and cleanly cuts any standard or extra-heavy soil pipe or tile, 2 through 4 in. By adding an extra chain, operator can cut 6-in. extra-heavy soil pipe or 15-in. tile. Once adjustment is made, company says, any number of cuts can be made without further adjustment. According to company, cutter takes 10 sec to operate, cuts cleanly without breakage, can cut slices as narrow as ¾ in., and is easy to use in close quarters or blind spots. Wheeler Mfg. Co.

8 — SAMPLE COOLER now available in stainless steel

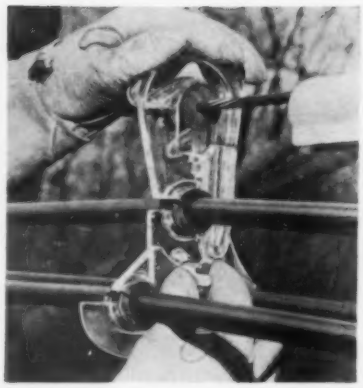
For applications in the petroleum, chemical and process industries, as well as power plants, this manufacturer's sample cooler is now offered in corrosion resistant stainless steel. The rugged counter-flow heat exchanger is coil-within-a-shell type construction and originally designed for sampling boiler water, steam feedwater and other hot fluids. Company engineers claim the sampler-heat exchanger is ideal for cooling high temperature chemical solutions and process liquids — at line pressures to 6000 psig — prior to testing at atmospheric conditions.

Because of its light weight — 18 lb — and slender cylindrical design, the stainless steel unit can be installed at critical check points in overhead piping and relatively inaccessible areas. Available with screwed or socket welding adapter sample connections, cooler can be integrated with any piping system. Mounting is facilitated by clamp type brackets, although unit can be mounted in piping. Hagan Chemical & Controls, Inc.

9 —SPEED REDUCERS adaptable to many mounting positions

In the Optimount series of helical-geared speed reducers, stock models of standardized units, for shaft mounting or base mounting meet almost all drive requirements. The series features a basic unit, with either single or double deduction helical gearing, which can be

mounted directly on the driven shaft or mounted in stock horizontal or vertical bases. Four sizes of the basic units provide output speeds of 10 to 431 rpm, and capacities of ¼ to 15 hp. Basic units come in three types. Optimount Reductors are designed for V-belt, sprocket or gear drive to input shaft. Optimount Ratiomotors provide direct motor drive to input shaft. Optimount Flanged Reductors are the Optimount Ratiomotor units sold without motor, ready for attaching motors of your choice. Boston Gear Works.



10 — CABLE SYSTEM is economical to install, maintain

This self-supporting aerial spaced cable system is specifically designed to provide a low-cost, easily installed replacement for conventional pre-assembled aerial cable, as well as to replace open wire lines where trees are a problem. The development, termed the Roebling Roeclamp with associated cables, requires only 1-ft clearance through wooded areas as compared to 8- or 10-ft clearance needed for open wire lines. The key is the Plexiglas Roeclamp. Each of these clamps receives three conductors and is suspended from a messenger which runs the length of the system. The messenger serves a double purpose in that it acts as an effective barrier against falling limbs or other objects, and it serves to provide protection from direct lightning strokes.

The Roeclamp itself installs in less than 1 min by the simple positioning of conductors and hand-tightening of a plastic bolt, it is noted, no tools being necessary. Thirty-five Roeclamps are required every 1000 ft. Other characteristics attributed to the new aerial cable system include: high current-carrying capacity; better voltage regulation; and ease of splicing and tapping. John A. Roebling's Sons Corp.

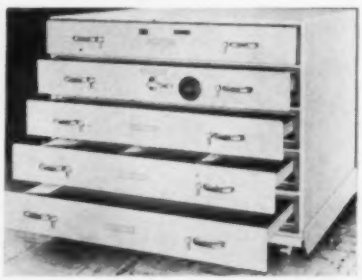
11 — CATION EXCHANGE RESIN resists breakage

Nalcite HCR-W is a cation exchange resin said to have greater physical stability than previously attained in a cation exchanger. The almost colorless beads are free of internal stress and strain, company says, and bead breakage, which creates fines that cause pressure drop build-up, is virtually eliminated. Operating temperatures as high as 250 F are claimed not to affect stability or capacity, making Nalcite HCR-W particularly suitable for use in hot-lime zeolite water treating plants. Company anticipates extensive use of Nalcite HCR-W in mixed bed demineralizers since its resistance to bead breakage will prevent fouling of the anion exchanger with fines from the cation. National Aluminate Corp.

12 — FLOOR COVERING is both resilient and non-slip

Scotch-Tred is flexible enough to be bent double, yet tests are reported to show that it outwears most popular floor coverings. It is suggested for use on walks, stairs and ladders; in locker rooms and showers; at the maintenance bench. Scotch-Tred can be applied in minutes, it is pointed out, and is ready for immediate use. You simply strip the protective backliner from the pressure-sensitive adhesive and press to a clean, dry surface. It is made with a dimensionally stable plastic film backing, a waterproof adhesive and a bonded-particle surface and weighs only 2½ oz per square foot, has a maximum thickness of 50 mils. Manufacturer says it is non-sparking, non-abrasive and resistant to oils, chemicals, solvents and many acids.

Although primarily a floor covering, Scotch-Tred can be used to protect walls subject to marring or impact damage, and to provide a sure-grip for tool handles. Conveyor belts can be stripped crosswise with it to gain additional non-marring traction and it is usable as pulley lagging. It is available in beige, black and gray in 96-ft rolls 4 to 36 in. wide, also in ¾-by-24 in. strips and in 9-by-9 in. tiles. Custom shapes can be ordered. A sample is offered. Minnesota Mining and Manufacturing Co.



13 — DRAWING FILE is fireproof and burglar-proof

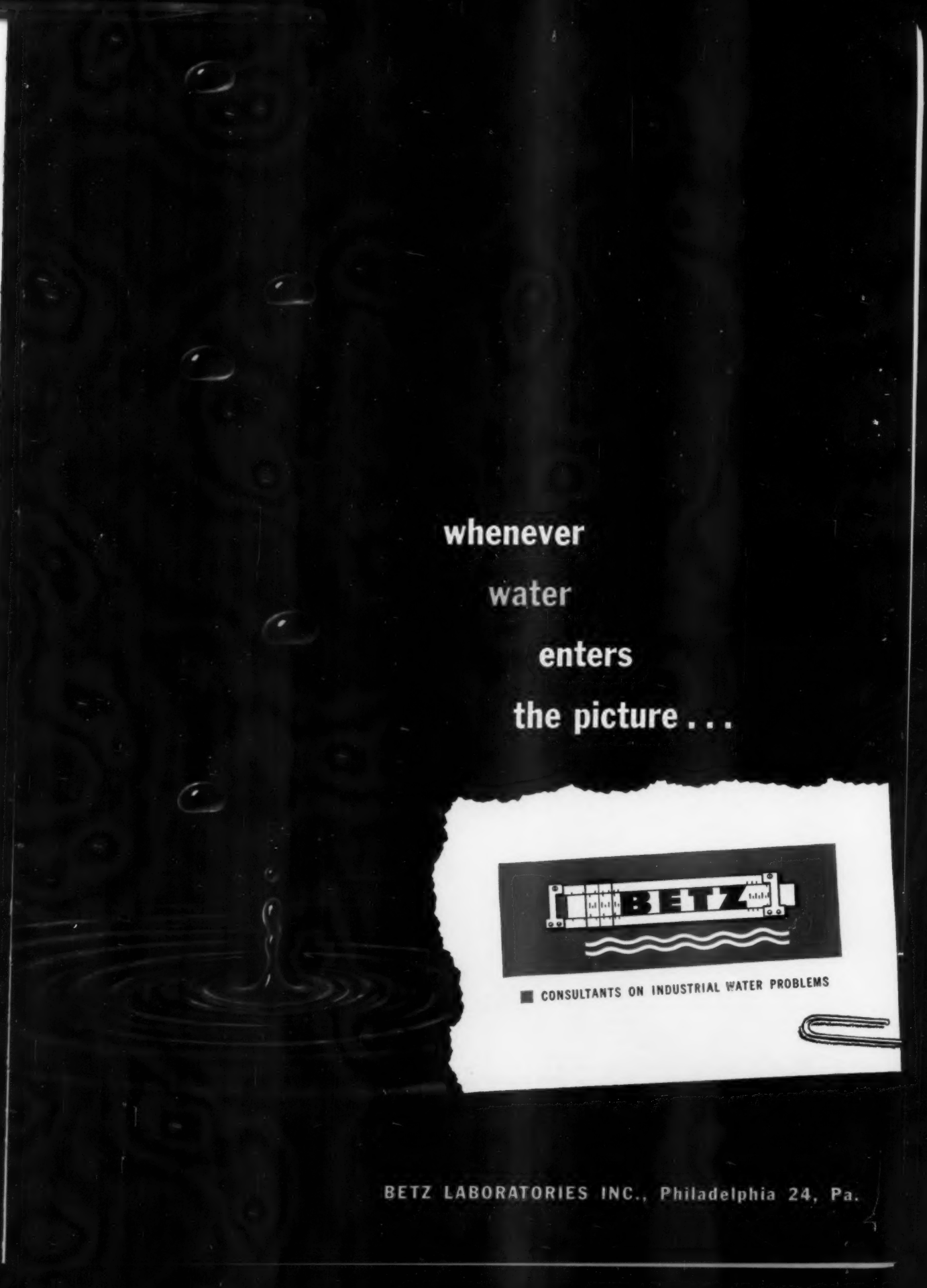
Valuable drawings can be protected from fire and theft in this file, it is stated. Drawings as large as 31 by 42 in. can be protected. The unit has a key lock at the handle and a drill proof steel plate located ahead of all locking mechanism. Also available are a combination lock or a manipulation-proof combination lock. Unit weighs approximately 1500 lb. Charles Bruning Co., Inc.

14 — GATE VALVE features double sealing action

The Wedge-Seal is announced as a leak-proof gate valve which incorporates Teflon seals in the wedge. As the wedge is lowered in the valve to a precision metal-to-metal fit against the seats, the Teflon seals on either side of the wedge compress against the seats to form a double sealing action. This double sealing action, company states, enables the Wedge-Seal valve to provide a positive shutoff both upstream and downstream, eliminating need for a double block and bleed in piping installations. In addition to its sealing action, Wedge-Seal is described as practical to service in the line. Available in both 150 and 300 lb classes. Remote control valves are also available. Hamer Valves, Inc.

15—STEAM BOILERS feature quiet operation, economy

WP (Whispering Power) Boilers are rated at 80, 100 and 125 hp. Major advantages announced are quiet operation and availability at prices as much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as a third below those of comparable units. Normally equipped for gas firing, they can be provided with an oil burner or with full combination gas/oil burner assemblies. Burners are provided for light fuel oils. The boilers are furnished as packaged units and reported capable of producing continuously at rated capacity or better without adverse effect or strain. These are horizontal, Scotch-marine type boilers with automatic control of firing cycle. Automatic shutoff is provided for flame failure or low water. Stack draft is not required, it is noted, only a short stub to take flue products out of the boiler room. Eclipse Fuel Engineering Co.

16 — FLOAT TRAPS with increased capacities

These continuous flow type traps are suggested for draining condensate from steam equipment continuously, and automatically, such as ahead of condensate meters. This continuous flow feature is also desirable for draining

moisture from air and gas purifiers, separators, receivers, tanks and similar equipment. Trap capacities range to 32,000 lb of water per hour, depending on differential pressure. Head and body are cast semi-steel, and the valve and seat of Anderloy, a corrosion-resistant nickel alloy. Other internal parts are stainless steel or bronze. The traps are designed for a maximum steam operating pressure of 250 lb. Furnished with or without a gage glass, these traps come in three sizes: No. 82 is tapped ½ or ¾ in.; No. 83, 1 or 1¼ in., and No. 84, 1½ or 2 in. The V. D. Anderson Co.

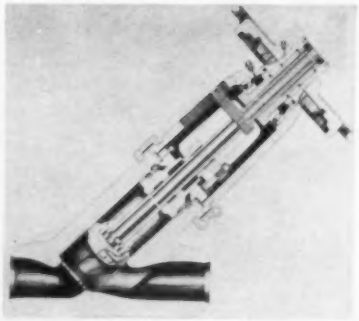
17—CONVEYOR BELT, reversible for more wear

Named for its ability to absorb and distribute shock, the Shockmaster Belt is designed to be turned over after the first carrying side is no longer satisfactory. It is described as a medium weight, double duty belt, flexible and having high impact resistance for use over smaller than usual pulleys on short center hauls. Shockmaster is made of two-or-three-ply heavy cotton nylon fabric with a skim coat of rubber between plies. An envelope ply of frictioned, double skimmed, heavy open weave nylon encompasses the core and acts as a cushion. Top and bottom covers are abrasion resistant rubber, 3/32 in. thick. This construction makes the belt unusually flexible without loss of bulk or strength, says manufacturer. This belt is reported advantageous where 45-deg idlers are necessary on narrow belting. Quaker Rubber Div., H. K. Porter Co., Inc.

18 — GLOBE VALVE cuts pressure drop way down

Claimed by manufacturer to have 70 per cent less pressure drop than best globe valves available three years ago, the Flite-Flow is intended for use where drop-tight shutoff is required and where pressure drop is important. The new steel globe valve is available in 1500- and 2500-lb classes from 10- to 18-in. sizes, and is primarily for steam generating plants rated 500,000 lb/hr and larger.

Chiefly responsible for the low pressure drop in the Flite-Flow are the internal contours of the flow passage; designs were worked out to reduce turbulence ahead of the valve seat and behind the valve seat. Flow approaching the seat is pre-shaped so that there is slight "squirting" action to carry fluid smoothly across the seat, company explains, and the downstream side is shaped to catch this flow with minimum turbulence. Edward Valves, Inc.

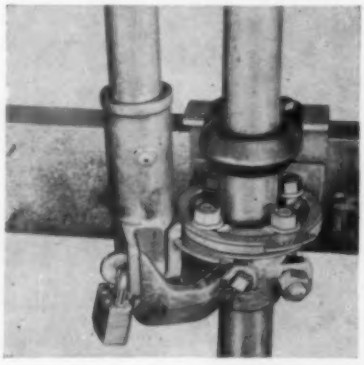


19 — DRY FLUID DRIVES in larger, smaller sizes

Added to the line of Flexidyne Dry Fluid Drives and Couplings are three larger sizes and a new small size, covering a capacity range from ¼ to 1000 hp. The larger ones include an 18-in. diam Flexidyne available either as a drive for use with V-belts, or as a coupling for direct shaft-to-shaft connection, either delivering up to 200 hp at 1200 rpm. The next larger size, the 22CK, is available only as a coupling and capable of transmitting up to 800 hp at 1200 rpm. Largest of the new units is a 27-in. coupling, 27CK, with a rating of up to 1000 hp at 900 rpm. For medium light applications, such as fans and small conveyors, there is a new 6-in. Flexidyne, available as a coupling or for use with V-belt drives; this unit is rated at up to 2 hp at 1800 rpm. Dodge Mfg. Corp.

20 — IMPROVED HANDLE makes for easier switch operation

For manual operation of power switches this hinged torsional handle is applicable to vertical-pipe operating mechanisms rotating through 180 deg or less. Company's sealed-contact, multi-revolution



grounding ring is an optional accessory. Main features of the handle are an up or down hinging, clockwise or counterclockwise rotation, stepless adjustment of "open" and "close" stops, and automatic unlatching. Additional features cited include simplicity of positioning handle, choice of wood or steel handle, padlock. The mounting plate may be bolted direct to a pole or substation structure. Line Materials Industries.

21—HYDRAULIC LIFTER speeds sludge removal in clarifiers

An overload control for slurry clarifiers is available for use with manufacturer's Reactivator, a water clarification and softening unit. The control is an hydraulic lifter on the sludge scraper shaft of the Reactivator which acts when heavy sludge prevents normal rotation of the scrapers. It raises them as high as 12 in. or more — depending on sludge volume — so they can remove the top layer of sludge and work down until the entire bottom area is cleared and scrapers can work in their normal position.

This mechanism is claimed to represent an economical solution to the problem of sludge settling on the bottom of the tank. An hydraulic pump and valve system activates the lifter. The pump can be operated manually, or by a motor. The motor may be initiated automatically or manually by a switch. The unit is described as easily installed. Graver Water Conditioning Co.

22 — SPREADING TOOL for flanged pipe connections

With Safety Boy, flanges can be spread safer, faster and more economically, it is announced. A feature is a circular cam wedge. This, plus use of a ratchet handle, provides a lightweight, handy-to-carry tool that will spread a flange in seconds, says manufacturer. Operation is simple. After flange bolts are loosened and necessary bolts removed, the tool is anchored onto flanges by insertion of pins into flange bolt holes, while at the same time inserting tapered edge of circular cam wedge into small opening between flanges. Pressure applied by ratchet handle spreads flange connection. Safety Boy can be used in limited working space. Wm. L. Riggs Co.

23 — CENTRIFUGAL EXTRACTOR for gas scrubber exhaust

This centrifugal moisture extractor is designed to remove free moisture from wet scrubber exhausts. Five sizes available handle exhaust gases from 10,000 to 35,000 cfm. The extractor changes the direction of exhaust gas flow from a vertical to a cyclonic path. Centrifugal action imparted by stationary impeller blades removes free moisture along with some of the entrained dust or solid particles. Moisture impinges on the inside of the outer shell and collects at a drain outlet for disposal. Cleaning and

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THE ALL NEW LESLIE-TOPPER assures you reliable, year 'round control in continuous, intermittent or stand-by service. Check these features available in *no* other valve.

- PACKLESS • METAL DIAPHRAGM • STELLITED STAINLESS STEEL SEAT RING
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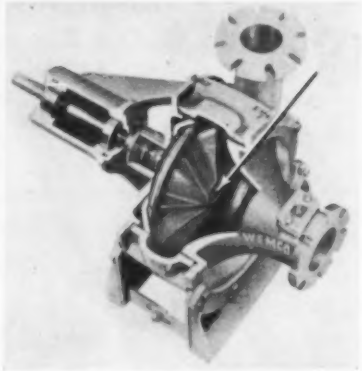
inspection of the steel extractor is facilitated by two Neoprene-gasketed inspection doors and a backwash nozzle at the apex of the stack. The operator controlled spray both cleans the vanes and flushes the stack. The nozzles consume 45 gpm at 60 psi during cleaning operations. The Johnson-March Corp.

24 — SOLIDS PUMP designed to eliminate clogging

In the Wemco Torque-Flow Pump a recessed impeller, located out of the flow pattern, produces a swirling motion transmitted to the fluid at the suction line by impeller action. Suction and discharge water become a continuous open passage from suction flange to discharge flange. The pump operates by transmitting power to a fluid pulp, as in a fluid type torque converter. It creates a vortex effect, causing pulp in main pump body to rotate. Particles and



solids drawn into the vortex of the swirling liquid are discharged with a centrifugal sweep from the open chamber, it is explained, seldom touching the impeller, indicated by arrow in illustration.

According to manufacturer, this pump handles anything that will enter the suction because of the open case — and is completely non-clogging. The pump is reported to handle coarse, abrasive, soft or fibrous materials — even frothy pulps. Low cost operation is also claimed, as the same design features providing protection to solids being pumped, also provide protection against excessive wear to the pump itself. Already in successful service in sewage and sludge handling installations, the Wemco Torque-Flow Pump is expected to have broad industrial application. Among the variety of materials announced as pumpable with it are cement, fruit, fish, pharmaceuticals, coal refuse, garbage, paper pulps and rags. Capacities range to 3000 gpm, and heads to 120 ft. Bulletin PIO-B6 gives data. Western Machinery Co.

25—NICKEL COATED VALVES offer corrosion resistance

This line of nickel-coated Rockwell-Norstrom lubricated plug valves is reported especially applicable in the refining, chemical, food processing and paper industries. These nickel-coated valves are claimed to have the same qualities of corrosion resistance as higher-cost solid nickel or stainless steel valves and with improved mechanical and physical properties. (The coating is applied by General American Transportation Corp., using the Kanigen

process.) Materials that can be handled with the nickel-coated valves are announced as including amyl acetate, amyl alcohol, benzol, benzyl acetate, benzol alcohol, carbon disulfide, dibutyl phthalate, ethyl alcohol, petroleum sour crude, petroleum white oil, refinery solution and others. Rockwell Mfg. Co.

Reader Service Cards on pages 121–122 make it easy to get further information on any of these products. Just circle the item numbers of the products you want to know more about.

26 — HEAT EXCHANGERS with cold weather protection

In these new models of Sectional Aero Heat Exchangers, operation is protected from freezing in extreme winter climates, it is announced. The machine's basic principle is cooling of a liquid by evaporation of a small amount of water on the surface of tubes through which the liquid passes — the machine maintaining temperature control within close limits by varying amount of outdoor air flow across coils, adjusting capacity to load, removing heat at rate of input.

The new "winter-summer" models enclose the air modulating dampers in a casing and provide for restriction of the air supply by a manually operated damper in winter climates where the temperature remains below freezing temperatures for extended periods. Automatic modulating damper operation continues, maintaining close temperature control. Heat supply for warm-up periods or between shut-downs is available from an outside source. Applications are to industrial fluid cooling systems, liquids and air and gases, mill water systems, and process temperature control. Niagara Blower Co.

27 — PORTABLE POWER COILER simplifies cable measuring

Electrical wire, wire rope, hose and plastic flexible pipe can be measured and wound into neat coils with Model C Reel-O-Matic, a portable powered coiler, it is announced. The coiler has a welded steel frame and is powered by a ½ hp. 110-v, capacitor-start electric motor. The unit is designed to pull cable from one-ton supply reels at 20 rpm. An accessory turntable permits the making of coil-to-coil cuts. The unit may also

Self-Contained Steam Production to Fit Your Need

19 SIZES
30 to 434 HP, S.B.I. Rating
Delivering 45 to 651 HP, Maximum Continuous Output

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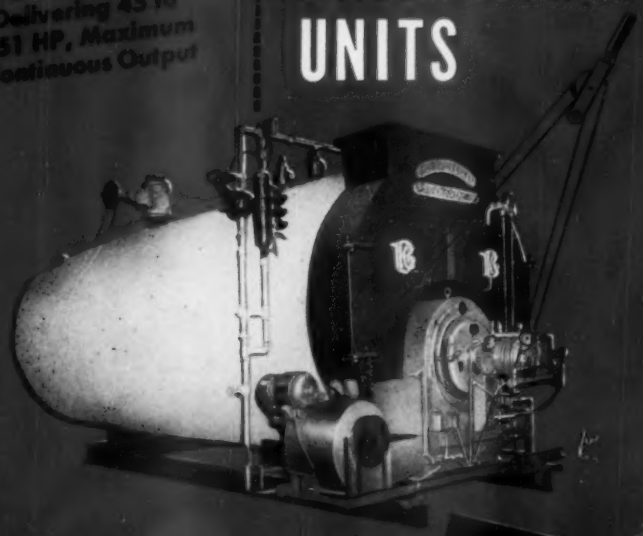

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Tubes correctly proportioned for efficient heat transfer promote 80% or greater efficiency.

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8.2 square feet of heating surface per boiler horsepower, (STEEL BOILER INSTITUTE STANDARD) provides maximum continuous output reserve capacity 50% greater than nominal S.B.I. rating.

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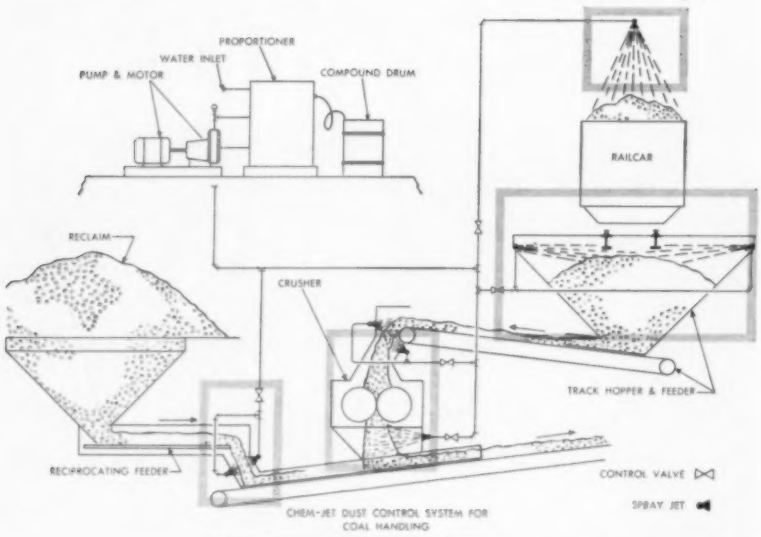
JOHNSON MARCH ► chem-jet DUST CONTROL SYSTEM



COAL DUST IS CONTROLLED at strategic points by Chem-jet system engineered for efficient, low-cost operation. Schematic diagram of Chem-jet system at large southern power company.

COAL HANDLING DUST STOPPED AT ITS SOURCE BY CHEM-JET

THE ONLY SYSTEM OF ITS KIND, Johnson-March Chem-jet is the low-cost dust control system that attacks a dust problem at its source . . . Chem-jet stops dust *before* it becomes airborne.

- Low-Cost Dust Control—
  Chem-jet means low first cost, low operating cost, minimum maintenance.
- Each Installation Engineered—
  Maximum effectiveness in dust control is assured because each system is designed to solve specific problems.
- Coal Treated With Compound M-R—
  Ends dust problem and eliminates the hazard of fire and dust explosion.

Engineering analysis of your dust problem will be made in your plant at no obligation. Write to Johnson-March Corporation, 1724 Chestnut Street, Philadelphia 3, Pa.

JOHNSON MARCH DUST CONTROL ENGINEERS

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be bolted to a special base to make possible rewinding on large wood reels as well as in coils. Larger size models and variable-speed, double-spindle ones available. Columbia Products, Inc.

28 — PNEUMATIC UNIT for interrupter switch control

For remote or automatic control of company's HPL-C metal enclosed interrupter switches, this low-cost system employs positive pneumatic switch actuation and can be incorporated on the HPL-C switches from 600 through

2000 amp and 2.4 through 14.4 kv. Consisting of a double-acting air motor, linkages, solenoid valve and air cylinder, the system permits three principal types of operation: remote pushbutton control; automatic throwover schemes; circuit opening on overload with thermal or overload relay sensing. The air cylinder, although usually in the switch enclosure, may be located at any point outside cabinet enclosure. The manual operating handle, normally used only during emergencies when the switch is pneumatically operated, is removed from the operating mechanism and bolted to the enclosure. A key interlock system serves to safeguard against accidental manual operation of the switch when it is under pneumatic control. R&IE Equipment Div., I-T-E Circuit Breaker Co.

29 — BUTTERFLY VALVES offer easy adjustment, accessibility

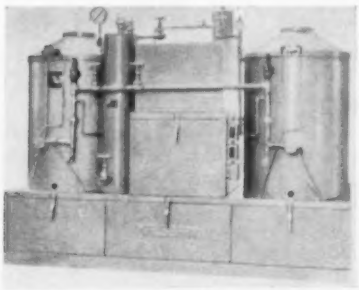
Outstanding features announced for the 32,000 Series of butterfly valves are ruggedized actuator mounting, ease of adjustment, accessibility and maximum actuator power delivery. An actuator plate has been designed to provide maximum support and permit the actuator to be adjusted along a slotted plate so that the actuator may be positioned to deliver maximum power with minimum angularity. This, according to manufacturer, enables the connecting stem and link to be in line and at right angles to the shaft arm at mid-stroke, for either 60 or 90 deg (or any intermediate point) operation.

Maintenance is simplified by oversized bearing brackets which permit easy access to the packing box and removal of the self-centering packing gland follower and gland to insert additional packing, without disconnecting linkage or detaching brackets. This valve series is also designed to simplify variations with extra parts or special tools. The valves are available with power, handwheel, or lever actuation. Sizes from 2 to 24 in. come in cast iron,

cast alloys or carbon steel, in ratings to 250 lb ASA iron, 300 lb ASA steel. Mason-Neilan Div., Worthington Corp.

30 — STEAM GENERATOR has two 15-bhp heater coils, burners

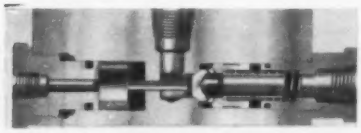
This flash-type 30 boiler horsepower steam generator is composed of two 15-bhp heater coils and two burners with individual controls, so either half



may be operated independently. The 30-bhp size has flash-type, continuous coil construction. This model produces dry, saturated steam in 2 to 3 min from a cold start, resulting in big fuel savings, company says, since burner operates only when steam is required. The steam generator is a complete package — installation is a matter of connecting to water, fuel and electricity. No special foundations or walled-in areas are necessary. Only 30 by 96 in. of floor space is needed. Malsbary Mfg. Co.

31 — CHECK VALVE with lifting poppet for reverse flow

This valve operates like the usual check, to which has been added a means for lifting the poppet from its seat permitting reverse flow. It is generally used on boom-and-lever installations to prevent cylinder creep, making certain a double acting cylinder remains in a



selected position until reverse movement is desired. In a typical installation, flow pressure at inlet (side port) raises poppet, actuating cylinder, with reverse flow impossible when poppet seats. With pilot port tapped into other cylinder connection, pressure to opposite end of cylinder pressurizes pilot which lifts check valve poppet, permitting reverse flow, and consequently, cylinder movement. Working pressure is 3000 psi hydraulic service and temperature range —65 to 250 F. Standard in aluminum alloy, with stainless steel trim, in sizes ¼, ⅜, ½ and ¾ in. FPT, or tube sizes 6, 8, 10 and 12. Republic Mfg. Co.

32—GEAR ASSEMBLY for use on wrench operated valves

This lightweight planetary gear operator is designed to adapt wrench-operated Rockwell-Nordstrom Hypreseal Valves — used on high pressure service — to gear operation. It can be installed by one man, manufacturer states, and has a 5 to 1 gear ratio and 4 to 1 mechanical

MAINTENANCE CUT 90%

ACE Rubber-Lined Ash Pipe

. . . saves 20 days a year turning and patching pipe at New Haven Railroad's Cos Cob Power Plant

Cinders and fly-ash pouring down this 300-ft. long pipe from the ash handling system of the New Haven Railroad's main power plant quickly scoured holes in cast iron pipe. To save trouble, the heavy pipe was rotated ⅛th of a turn every three months, a few sections at a time. The job took five days.

Then Ace rubber-lined pipe was installed. Its remarkable abrasion resistance kept it in service for three years before turning! Even then, its light weight made it possible to turn 200 ft. at once, finishing the job in one day instead of five.

Ace pipe, lined with rubber developed especially for ash systems, offers *you* these savings too. It's one of *nine* types of Ace plastic and rubber pipe made for tough jobs.

AT LAST! A PERMANENT CURE FOR CONDENSATE RETURN LINE CORROSION

Extensive tests show Ace Tempron pipe... rigid, heat-resistant nitrile hard rubber ...is immune to hot, corrosive steam condensate. Ask about it.

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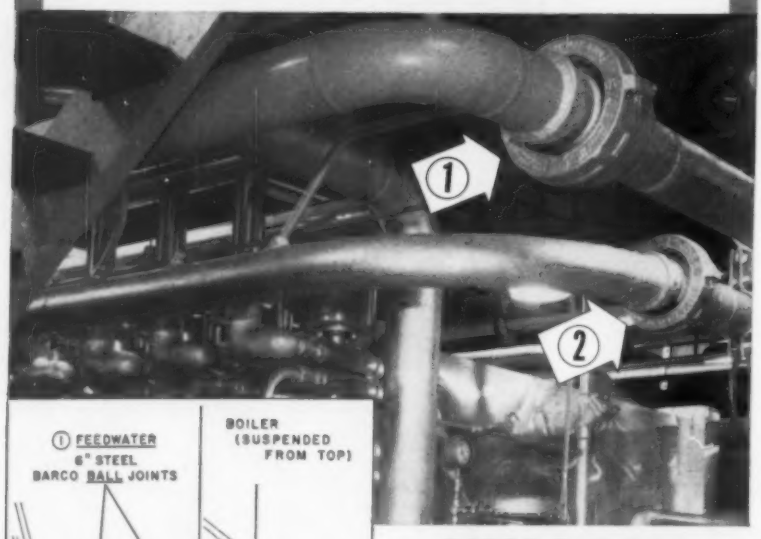
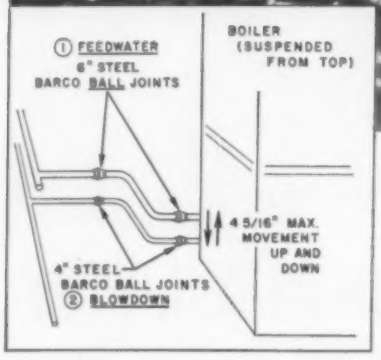
. . . where BOILERS move UP and DOWN





BARCO Ball Joints

The schematic diagram at left shows how Barco Flexible Ball Joints of steel construction are used in a new Florida utility plant—design pressure 600 psi, 500°F. The above photo shows a close-up view of two of the joints (see arrows). Two more matching joints, 4" and 6", are located out of the picture to the left. The 4" joints have metal gaskets. The same utility also uses 10" Barco joints on gas fuel lines. Other uses in power plants are for flexible connecting lines to oil burners, soot blowers, and other auxiliary equipment.

Flexible Pipe Connections!

The rapidly increasing use of Barco Flexible Ball Joints for solving piping problems in POWER PLANTS is significant for several key reasons:

1. Substantial *space saving* as compared to other methods in crowded piping areas.
2. Unlimited flexibility and movement. Utmost simplicity.
3. No heavy pipe anchoring required. No "end thrust" developed under pressure.
4. Ability to handle compound movement (where twisting is combined with thermal expansion and contraction).
5. Easy to engineer joints into piping to provide for any degree of flexibility, expansion, or movement required.
6. Maximum safety for high temperature applications. All-metal construction available. Special alloys can be specified.
7. Basic design is pressure sealing against leakage and self-adjusting for wear.
8. Virtually no deterioration. Able to stay in service for years without repairs or maintenance. No lubrication.

New Bulletin No. 31 contains interesting diagrams showing how to solve many common pipe expansion problems EASILY, ECONOMICALLY. *Ask for a copy;* see your nearest Barco representative or write:

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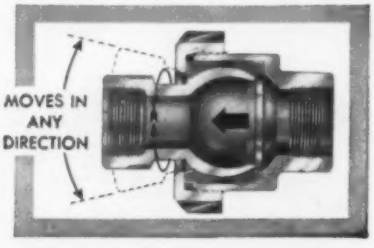

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advantage. A turn of a wrench or handwheel closes or opens it. Developed primarily for valves already in service, the gear operator fits over the square plug stem and down over the body of the valve. Company says no special wrenches or handwheels are needed — the one normally used will fit over the operating pinion. Attachment requires only tightening of a set screw on the valve plug stem and adjustment of two top screws which contact the packing injector box. The plug stem projects through the gear operator, causing no interference with valve's lubricating fitting. The assembly comes in three sizes. Meter and Valve Div., Rockwell Mfg. Co.

33 — SHIELDING zips around the wires and cables

Shielded Zippertubing is closed by a plastic or metal zipper track and may be zipped around wires and cables to give full coverage. According to manufacturer, one man can close about 20 ft of Zippertubing per minute. For regular RF shielding, either copper or an aluminum foil is laminated to a vinyl

saturated Fiberglas to provide immediate grounding of RF and UHF interference.

For magnetic shielding, Co-netic steel, laminated between layers of insulating materials is available, and any combination of vinyl, Mylar and Fiberglas may be selected for insulation. Radiation Zippertubing is also available to protect cables, wires and controls from nuclear radiation. Made of vinyl covered, lead saturated glass cloth, the jacket may be zipped off and replaced when contaminated. Shielded Zippertubing comes in inside diameters from $\frac{3}{8}$ in. up. The Zippertubing Co.

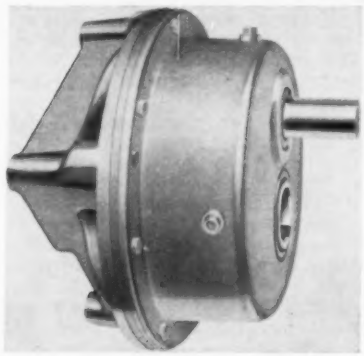
34 — SPLICE BOX is compact and easy to install

"Pull-n-Splice" is announced as a splice box for cable that combines moisture-, fungus- and corrosion-resistant features with greater compactness and installation ease. This above-ground box consists of a cast-iron base hot-dipped galvanized with two threaded conduit hubs for incoming mains. Phase legs can be spliced through the one-piece cast copper alloy connectors. These are so spaced as to provide greater clearances to ground and between phases, it is explained, eliminating need for barriers for installations up to 600 v. A galvanized, easily-removed domed cover completes the assembly, making a readily accessible pull box less than half the size of many below-ground pull boxes or manholes. For services to 5 kv, insulated pigtail splices of the phases are recommended by manufacturer; therefore no panel assembly is provided but higher domed covers are furnished, giving

room for taping. Units come in both weatherproof and explosion proof designs. O. Z. Electrical Mfg. Co.

35 — FLANGE MOUNTED DRIVE bolts to driven machine

This compact gear drive bolts directly to the driven machine. The unit is designed with bearing capacities for overhung and thrust loads to allow installation of this drive into the driven

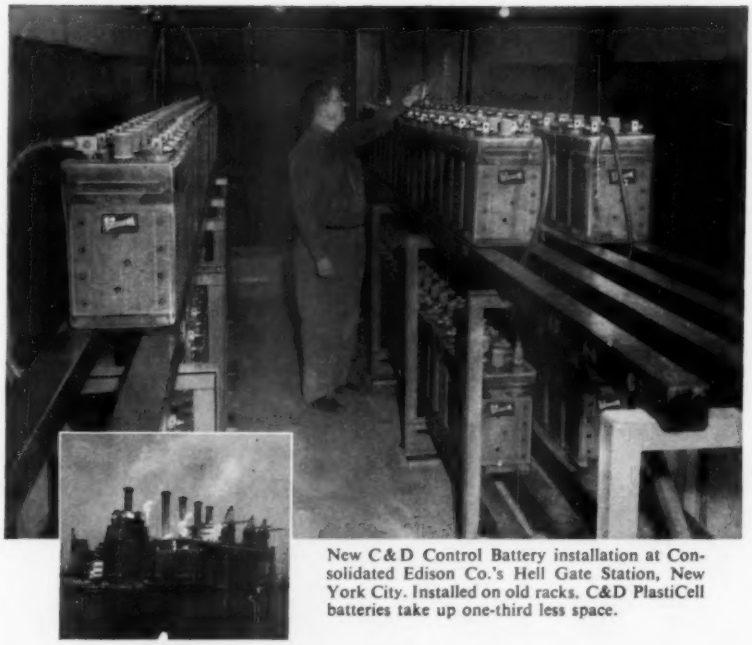


machine as a geared pillow block, if desired. Thus, states manufacturer, you can eliminate one bearing and cut down the overall size of the installation. These drives are available for horizontal or vertical applications, with high speed shaft up or down. They are furnished from stock in single reduction for applications of ½ to 10 hp and in two double reduction ratios for ½ to 5 hp. Bulletin 7140 gives details. The Falk Corp.

36 — IMPROVED AMMETER measures both a-c and d-c

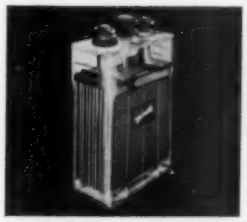
Included in engineering changes in the new Tong Test Ammeter is a larger damping chamber for each scale range which makes readings easier by providing improved damping characteristics. Other new features noted are

heavier and stronger scale range construction, insulated operating trigger and plastic handle. To operate Tong Test all you have to do is press the trigger and snap the tongs around an electrical conductor without breaking circuit or insulation — and readings are obtained. Tong Test is constructed without coils or windings so there is no danger of burnouts, company says. It is available in eight types and measures up to 1000 amp, and is equipped with larger interchangeable ranges to make it impossible to read wrong scale. Columbia Electric Mfg. Co.



New C&D Control Battery installation at Consolidated Edison Co.'s Hell Gate Station, New York City. Installed on old racks. C&D PlastiCell batteries take up one-third less space.

Con Edison saves 1/3 space



...when replacing control batteries by installing C&D PlastiCell

Consolidated Edison, supplying the tremendous power demand of New York City and Westchester, recently replaced another make battery supplying the d-c house bus at its Hell Gate Station with a C&D PlastiCell battery.

The result—
a saving of a third of battery room space.

The C&D PlastiCell battery is used to control the motor-operated valves on gas and steam lines in connection with 900,000 pound per-hour high-pressure boilers and 450,000 pound per-hour low-pressure boilers. In addition, the battery supplies power for sequence trip controls, cubicle switches, forced and induced draft fan controls, and solenoids for motor breakers.

For space-saving, yes—and even more important, for complete dependability, long life, and reduced maintenance, specify C&D—the batteries engineered for control service. That's why C&D is your better battery buy. C&D batteries are engineered to provide a long, trouble-free service life. With PlastiCell (lead-antimony) you get a full 14 years of life and with PlastiCal® (lead-calcium) 25 years.

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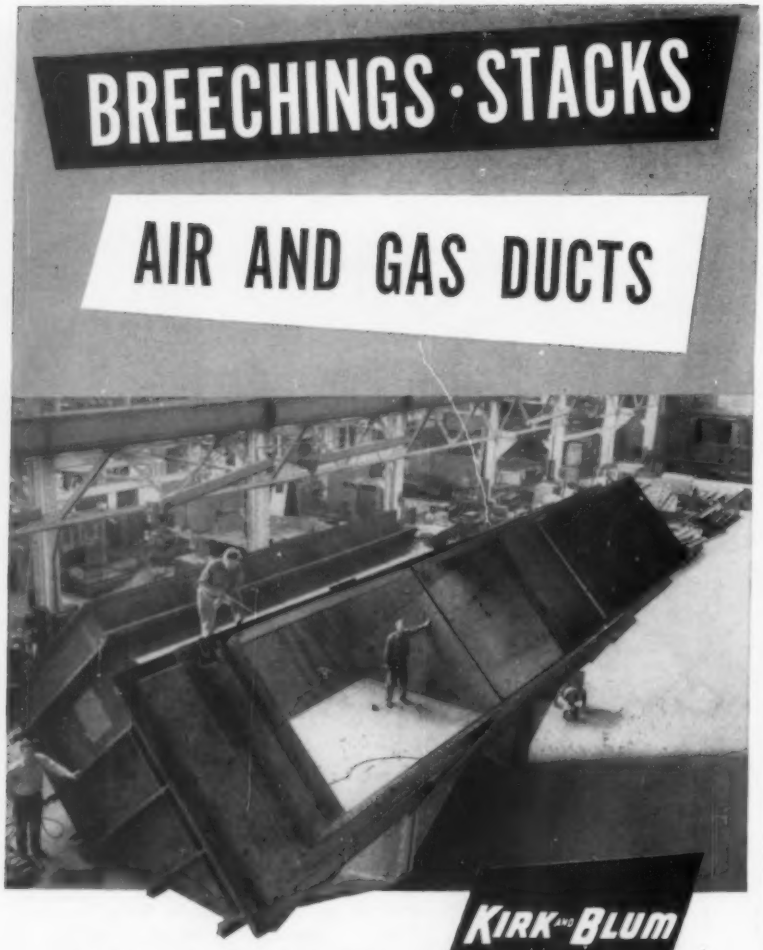

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Obituaries

John M. Drabelle

JOHN M. DRABELLE, consulting engineer and retired chief engineer for the Iowa Electric Light and Power Co, died June 7 in a Cedar Rapids hospital following a stroke. He was 71.

Holder of various patents and author of numerous technical articles, Mr. Drabelle retired from the light company in 1952 after 42 years service. Since then he had been a consultant for Allis-Chalmers on foreign power station design and installation. His career spanned more than 30 years of engineering work in both the electric and gas utility fields.

He was known to power engineers everywhere in this country and in many foreign countries. Readers of POWER ENGINEERING are familiar with his recent articles in the magazine: King-Size Cooling Towers Today Serve Steam Generating Stations; Flame Rotation on Adjacent Oil Burners; Take a New Look at the Extraction Heater; and others.

He was a Member Emeritus of Iowa Engineering Society and also held membership in National Society of Professional Engineers. In 1950 he received the Anson Marston award from Iowa Engineering Society for distinguished service to the society.

He was past president of the Midwest Gas Association, the Iowa Public Utilities Association and the Cedar Rapids Engineers club. Other groups with which he was affiliated included: ASME, AIEE (Fellow in both organizations), the American Gas Association, Edison Electric Institute, NAPE and Pi Tau Sigma.

Walter B. Morton

WALTER B. MORTON, 62, died at 3 A.M., July 7, at his home, 915 Delaware Ave, Bethlehem, Penna. He was chief electrical engineer for Pennsylvania Power & Light Co and had served with the local utility for nearly 13 years.

Nationally prominent in engineering fields, he was a Fellow, chairman of the Administration department, past vice president, and past director of the American Institute of Electrical Engineers; member of Edison Electric Institute; Illuminating Engineering Society; Institute of Radio Engineers, National Society of Professional Engineers; Engineers Joint Council and American Society for Engineering Education. He was also a member and past president of the Engineers Club of the Lehigh Valley and of the Engineers Club of Philadelphia; a member of the Lehigh Valley Club; and was a registered professional engineer in the states of Pennsylvania and New York. He retired from the Navy as Captain, USNR, in 1956. He was a Navy veteran of World Wars I and II.

NEW ENGINEERING BOOKS

Pump Selection and Application, by Tyler G. Hicks, 432 pages, 6 by 9¼-in., cloth. First Edition, 1957. Published by McGraw-Hill Book Co, 327 W 41st St, New York 36, N. Y. Price $8.50.

The purpose of this book is to show the reader how to get more economy and efficiency from pump installations in all the diverse fields where this equipment is used. Pumping problems of a number of industries are comprehensively covered.

Part I, on pump classes and types, includes centrifugal pumps, rotary pumps and reciprocating pumps.

Part II is devoted to pump selection, under the following sections: head on a pump, pump capacity, liquid handled, piping systems, drives for industrial pumps, pump selection, pumping-system economics.

Part III discusses pump application in the following: power-plant services; nuclear energy applications, petroleum industry, chemical industries, paper, textiles and rubber, food processing and handling, water supply, sewage and sump services, air conditioning and heating, irrigation and flood control, mining and construction, marine services, industrial hydraulic and vacuum pumps, and iron, steel and other industries.

The book is generously illustrated. Tyler Hicks is instructor in mechanical engineering at Cooper Union School of Engineering.

* * *

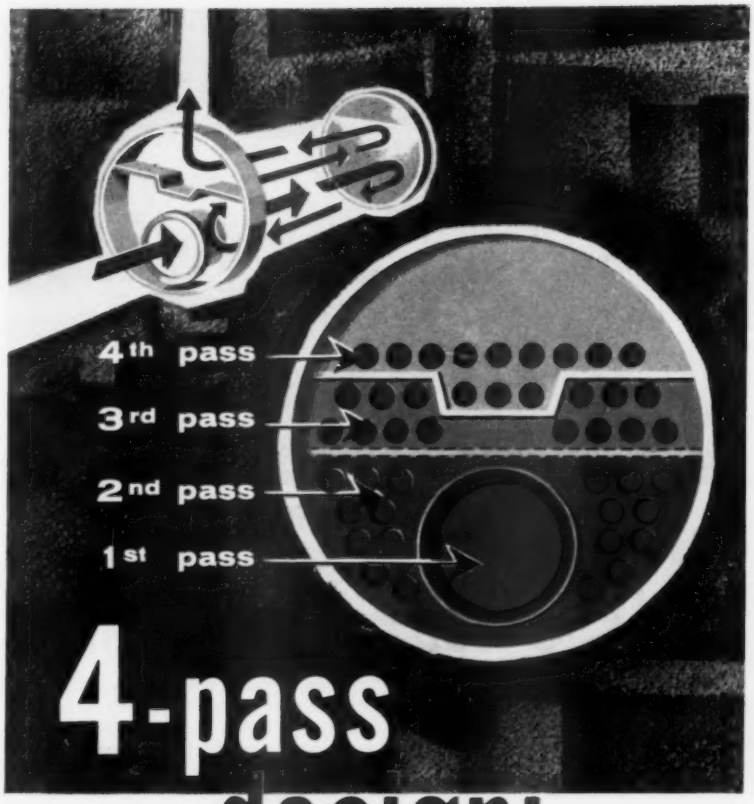
Professional Engineer's Examination Questions and Answers, by William S. La Londe, Jr. First Edition, 1956. 462 pages, 8¼ by 5¾, cloth. Published by McGraw-Hill Book Co., 330 W. 42nd St., New York 36, N. Y. $6.50.

This book has been prepared to help both the newly graduated engineer and the older practicing engineer in preparation for the professional engineer examinations as part requirement for a professional engineer's license.

The book consists entirely of questions and answers selected to show exactly the type of questions to be expected at the examination. They have been taken from recent actual examinations for the Professional Engineer license, the Land Surveyor License, and the Engineer-In-Training Certificate.

The author is well qualified to make these selections. For the past twenty years he has prepared or consulted in the preparation of the New Jersey state examinations.

The questions in this book cover all major phases of professional engineering examinations. There are questions in fundamental engineering, and in chemical, civil, electrical, and mechanical engineering. The questions do not represent the exam questions



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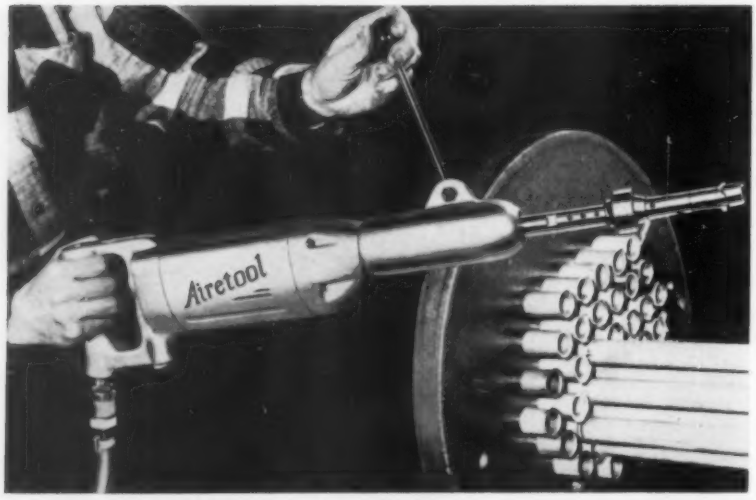

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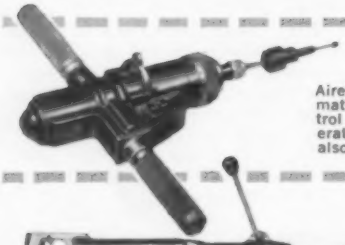

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Engineering Books

continued from page 117

of any particular state, but they have been selected to give a composite of many examinations so that they will be suitable for examinations in any state.

★ ★ ★

Heat Transfer — Volume II, by Max Jakob. First Edition. 652 pages, 6 by 9 in., cloth bound. Published by John Wiley & Sons, Inc, 440 Fourth Ave, New York 16, N. Y. Price $15.00.

This is the second of two volumes, the first having been published in 1949. Together the books constitute one of the most critical, complete and authoritative examinations of the subject in the English language.

At the time of Dr. Jakob's death in January, 1955, he had been working on the second edition for six years, and the bulk of it was complete. During the following two years, his associate and former student, Dr. Stothe Kezios, completed technical details, and consolidated and edited the work, in itself an undertaking of considerable proportions.

Book is in three parts, the first of which, Part F, Heat Radiation in Spaces of Simple Configuration, can be considered as falling under the general organization of Volume I. Part G, Selected Fields of Application, constitutes the main subject matter of the volume.

Part H, Supplements to Volume I, introduces new material pertinent to the first book, which material became available only after publication.

The thorough mastery and critical nature of the subject by the author is evident throughout the book. As a particular example, the chapter on regenerators probably represents the most complete treatment of basic regenerator theory to appear up to the present time.

Moreover, the attention paid to the historical side of developments within a particular topic is valuable to the student and researcher alike.

★ ★ ★

Fogle's Engineer's Handbook. 1958 Edition. Appr. 100 pages, 8½ by 10½ in., paper bound. Published by William Fogle, Box 2322, Station 28, Los Angeles 28, Calif. Price $15.00.

This seems to be a new concept of an engineer's handbook, a sort of soup-to-nuts collection of the many design and detail problems which are likely to confront a power engineer in the course of his work. All the calculations are completed, drawings are shown, and dimensions are provided for broad variations of each individual design. From here the engineer need only make his take-offs, or turn the information over for fabrication, construction or erection.

Piping, pipe supports, piping schemes are covered in detail. Specifications for welds,

rivets and bolts of various types are set forth and illustrated. Insulation of pipes, vessels and tanks is treated completely.

Supports of all types, brackets, gratings, ladders, platforms, including weights and loads supported, are drawn and specified, in detail.

Unusual items treated include such items as manhole covers, dimensions for parking lots and all kinds of docks, vehicles and railroad cars, foundations for oil tanks, wind loading and foundations for stacks, thermocouple wells, wrench clearances, and others.

Capacity and weight of all types of tanks are given in comprehensive tables. Charts present the proper symbols for use in various engineering work. The publisher reports that all applicable standards and codes are respected in each case.

★ ★ ★

Marine Electrical Practice, by G. O. Watson. First Edition. 325 pages, 8½ by 5¾ in., cloth bound. Published by Philosophical Library, 15 East 40th St, New York 16, N. Y. Price $12.00.

This book of British origin, is intended for the marine engineer when he has mastered fundamental formulae and elementary principles, and begins to apply himself to practical problems. It is outstanding for its clarity, and for that reason is ideal for engineers who are studying for examinations which will upgrade them. Nor is it to be overlooked that, though it is based on marine practice, this feature makes it of great value to the engineer working with land-based plants.

It is a thorough, rigorous treatise on the entire field of marine electricity, yet it is decidedly practical. The maintenance and periodic testing of electrical equipment receives a great deal of attention.

Undoubtedly the outstanding feature of the book, however, is the chapters on a-c generators and their voltage regulators. Here the clarity of the writing is most impressive, and to those of us who for years have been a little mystified by these regulators, their operation seems to stand in a new and clearer light.

Most of the switchgear and other equipment discussed in the book is of British or continental origin, but the principles of operation are nearly identical to the American counterparts, so that this does not decrease the value of the book. It may in fact enhance it for some, who enjoy contemplating how things may be done just a little differently.

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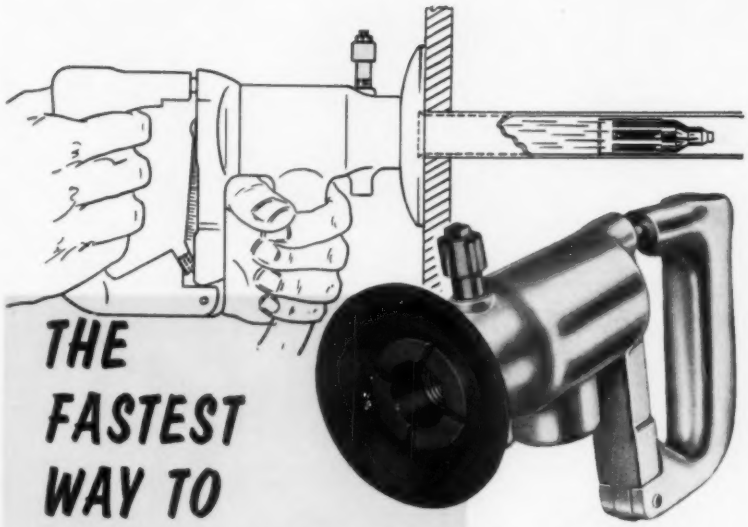

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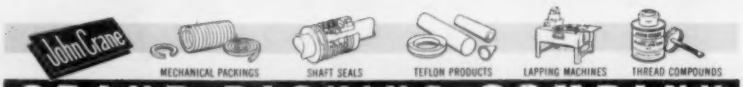

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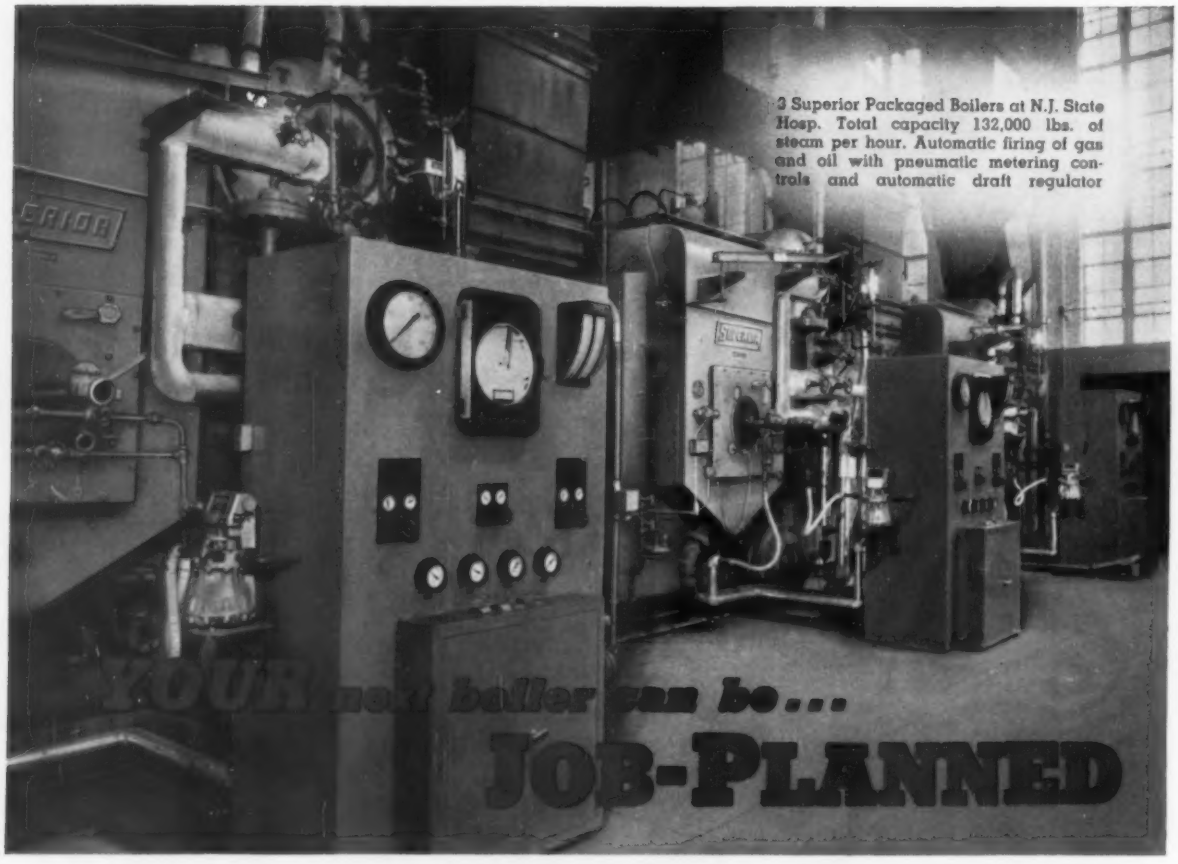
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VALVES, TRAPS AND PIPING

201 Boiler Blow Off Valves — Bulletin E-125, 24 pp, describes and illustrates the design and construction of company's quick-operating valves, angle valves, Y valves and duplex units specifically designed for boiler blow-off service. Includes dimensions. Everlasting Valve Co.

202 Industrial Valves — Condensed Catalog 105, 28 pp, contains data on valves for a wide variety of applications. Includes dimensions and illustrations, describing non-return (stop-check) valves, globe and angle stop valves, pressure seal design, angle univalves and small size globe valves designed for chain or extension operation in vertical lines. Edward Valves, Inc.

203 Regulating Valves — Bulletin 5305 describes double seated diaphragm regulating valves for use with control instruments, outlining special features of the valves, particularly the "flow line" contoured-body engineered for high capacity at low pressure drop. Leslie Co.

204 Flow Regulating Valve — Bulletin 1053 describes and illustrates the flow regulating valve which offers two distinct advantages: use of a horizontal rotating lever shaft, and accurate balance in service. Included in the bulletin are specifications on sizes, pressures, and materials of construction. Copes-Vulcan Div., Blaw-Knox Co.

205 For High Pressures, Temperatures — Bulletin B-453, 12 pp, describes company's high temperature and high pressure valves for service in steam power plants and related installations. Cutaway views illustrating design and construction features are included, as well as temperature-pressure ratings table, selection chart, dimensions, weights. Yarnall-Waring Co.

206 Butterfly Valve Manual — Forty-pp Catalog B-2 is designed to help power engineers select valve types, understand their characteristics, and determine space requirements. It includes such useful data as: pressure drop and flow tables, conversion tables, theory and application, recommended materials, and describes rubber seat butterfly valves from 4 in. diam up, for handling liquids and gases. The Henry Pratt Co.

207 Check Valves — Twenty-pp Catalog 30A presents company's line of tilting-disc check valves made in iron, bronze and steel for working pressures to 2500 psi. Explains operating principles of tilting disc construction, discusses closing without slam, reduced loss of head, other advantages. Includes construction details, sizes. The Chapman Valve Mfg. Co.

208 Choosing the Right Valve — Presenting valve selection as a matter of matching the valve's service characteristics with service requirements of the job, this practical 20-pp booklet explains and

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209 Industrial Valves — Bulletin 507V illustrates and describes company's line of industrial valves for control of air, gas, liquids and solids. Features photos and descriptive detail on a variety of valves, including butterfly valves, wafer butterfly valves, treaded butterfly valves, slide valves, check valves, proportioning valves and others. W. S. Rockwell Co.

211 To Get at Those Valves — This little folder describes a sprocket rim with chain guide. The rim adjusts to fit all valve wheels. Babbitt Steam Specialty Co.

212 Steam Traps — Bulletin 455-B describes a float-thermostatic steam trap designed to discharge condensate at steam temperature continuously and without shock. Operation and construction features are outlined, and size and capacity data included. Sarco Co., Inc.

213 Water Hammer Control — Cause, effect and control of water hammer in piping systems is the subject of 8-pp Bulletin WH 851. Photos, drawings and curves supplement text, and tests data is presented to show efficiency of company's silent check valves in water hammer control. The Williams Gauge Co., Inc.

214 Trap Service Guide — To promote better trapping practice, pocket-size 32-pp Bulletin 7511 offers practical tips on installation, testing, and maintenance. Chapters are devoted to inspection and repair, trouble shooting, parts identification. Capacity charts are provided, also tables showing interchangeability of company's trap parts. Other sections deal with strainers, check valves, automatic trap drains. Armstrong Machine Works.

215 Materials for Main Steam Piping — Entitled "The Plastic Ductility of Austentic Piping Containing Welded Joints At 1200 F," this 16-pp bulletin deals with an investigation into the problem of selection of materials for main steam piping. Gives stress rupture characteristics of type 316 and 347 stainless steel piping adjacent to welded joints. Pittsburgh Piping and Equipment Co.

216 Flexible Hose, Bellows — Sixteen-pp Catalog 156 describes applications and use of flexible metal hose and bellows. Engineering specifications and sizes, pressure ratings, materials and fitting attachments are included. Detailed drawings and pictures facilitate specification of individual applications. Flexonics Corp.

217 Swing Joints — Eight-pp Catalog 400-A describes a line of ball bearing type swing joints specifically designed for loading and unloading lines handling oils and gasoline, gas and many chemicals. Dimensions and specifications are included, applications detailed. Barco Mfg. Co.

LUBRICATION

218 Versatile Industrial Oil — Described in 20-pp Form AD 4078 is an all-purpose oil offering protection for a wide range of industrial equipment, and available in 15 viscosity grades. Discusses six major characteristics of the oil; explains and pictures its use in hydraulic systems, speed reducers, air compressors, electric

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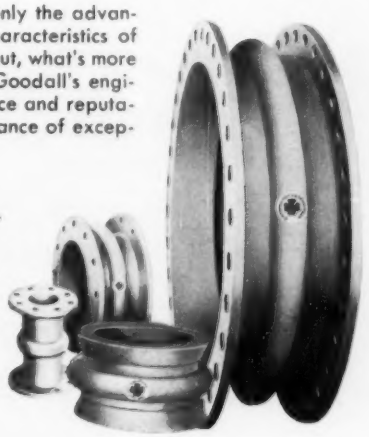

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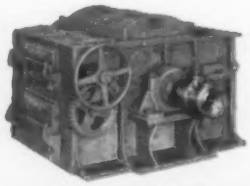

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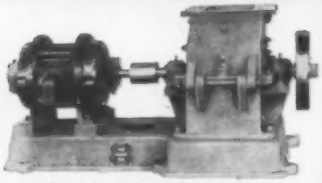

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motors, hydraulic turbines, bearing systems, etc. A chart shows grades available, uses, properties. Standard Oil Co. (Ind.)

219 Lithium Greases — This product information bulletin presents manufacturer's six Litholine industrial greases, stressing industry advantages offered by these multi-purpose greases. Gives properties of the greases, general application and performance characteristics and includes test data. Sinclair Refining Co.

220 Lubricants — Specification, Classification — Vital information on selection of lubricants is presented in 10-pp Vol. 41, No. 4 of "Lubrication." Covers such items as performance specifications, initial suitability of lubricants, quality of lubricant, effect of lubricant on production, effect on maintenance, effect on power, effect on cost, and features a look to the future. The Texas Co.

ELECTRICAL EQUIPMENT

221 Testing Instruments — Bulletin 19-58, 16 pp, features company's electrical testing instruments, including ohmmeters, ground testers, dielectric test sets, motor rotation tester, cable fault locating equipment, transformer turn ratio test sets, corona test equipment, frequency meters, tachometers, others. Includes photos and descriptions of each type, covering chief features. James G. Biddle Co.

222 Handbook on Fuses — This 12-pp booklet contains practical information on how to get safe, dependable, trouble-free electrical protection. Shows what to do when fuses blow, how to determine cause of blows, what kinds of fuse to use for various circuits. Contains short history of fuses and notes on construction of fuses. Bussman Mfg. Div., McGraw-Edison Co.

223 Battery Service Tips — Latest information on industrial batteries on cycle service is provided in the new edition, about 40 pp, of company's industrial battery service manual. Includes photos, charts, tables, repair methods, maintenance, and salient points on operation, instructions covering repairs with regular or special tools. Also covered are simplified testing methods (including safety practices and acid-handling precautions), and charging methods. C & D Batteries, Inc.

224 Cable Troughs — This 12-pp catalog offers a simple solution to any design problem of change of direction or elevation with a complete set of standard fittings, horizontal elbows, inside and outside vertical elbows, ties, crosses, covers and many special fastening devices to save time and labor. Contains full instructions for installations, load charts, accessory items. The Globe Co.

HEATING

226 Overhead Heating Units — Bulletin P 1-57, 16-pp, contains photographic reproductions of overhead gas-fired heaters, as installed in a variety of commercial and industrial plants. How this type of heating solved specific heating problems is told. Prat-Daniel Corp.

227 Unit Heaters — Bulletin FAS-1, 24 pp, describes horizontal and vertical discharge unit heaters for replacing process exhausted air with warmed fresh air and for comfort ventilation. Dimensions, capacities, and suggested methods of installation are given, and photos and drawings are included. L. J. Wing Mfg. Co.

228 Electric Heating Units — Catalog 50, 50 pp, contains complete engineering data on electrical heating units and equipment, including strip elements, finstrip elements, tabular elements, cartridge elements, ring elements, immersion heaters, circulation heaters, radiant heaters, forced air duct heaters, unit heaters, hot plates and others. Includes photos, dimensional drawings, prices, standard rating tables. Edwin L. Wiegand Co.

BOILERS, GENERATORS

229 Fire Tube Boilers — This 12-pp catalog describes Superior Compact packaged boilers in capacities from 20 to 200 bhp. Interesting arrangement of text, illustration and color is used to explain many features of the units. Gives complete data and dimensions for boilers designed for firing oil or gas or both. Superior Combustion Industries, Inc.

230 Automatic Boilers — Bulletin BE-4 describes operation and advantages of Continental automatic boiler's spinning gas technique — a method of obtaining maximum heat transfer with a simplified design. Shows cutaway view of boiler construction; illustrates hinged doors and method of injecting air. Boiler Engineering & Supply Co., Inc.

231 Self-Contained Boilers — Bulletin AD-162, 8 pp, describes company's complete line of self-contained boilers for heating and processing steam or hot water. Design features and advantages are detailed and a cutaway view showing flow of air in the forced draft system is included. Cleaver-Brooks Co.

232 Packaged Steam Generator — Advantages of company's baffleless, pressurized two-drum water tube packaged units are detailed in 12-pp Catalog SB-59. Features of the completely integrated generating plant, which requires no field piping, wiring, brickwork or special foundation, are shown on cutaway illustration. Erie City Iron Works.

233 Compact Generator — This bulletin describes a packaged water tube generator, company's Type DK, available in units from 6000 to 60,000 lb of steam per hour. Gives features, size and capacity data on these boilers which are designed to require less space than many water tube units. E. Keeler Co.

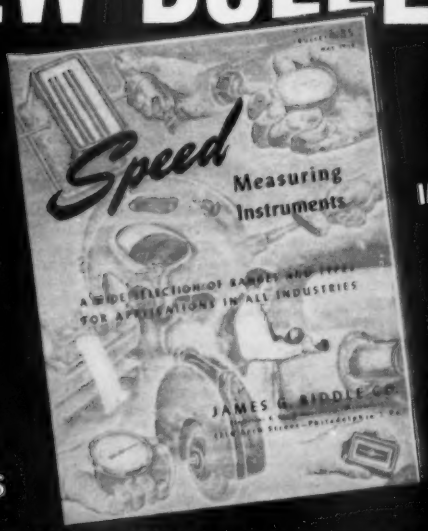
234 Standard Generators — Bulletin BB-55-4 describes company's SC economy series of standard steam generators designed to reduce steam costs for industrial plants. Pre-engineered, standardized steam generators offered in nine sizes, with capacities of from 50,000 to 150,000 lb per hour are described, and schematic and cutaway drawings of design features are included. Foster Wheeler Corp.

COAL AND ASH HANDLING

235 Improved Crushers — Bulletin 12-C, 16-pp, describes company's line of crushers for reducing coal, coke, glass cullet, gypsum, lime, metal turning, sugar, sulphur and similar lump materials. Covers Knittel ring type crushers, two-stage double-roll crushers, single-roll crushers, and double-roll crushers. Photos, dimensional drawings and full specifications are included. Stephens-Adamson Mfg. Co.

236 Shredders, Crushers — Bulletin 257 describes and illustrates hammermills

NEW BULLETIN



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JAGABI Triple-Range Hand Tachometer	Centrifugal	up to 40,000 rpm	3 individual ranges—12-inch scale—Twice around dial—wide range in each range
JAGABI Single-Range Tachometer	Centrifugal	300 to 4,000 rpm	Exceptionally wide range—Double length 12-inch scale
JAGABI Single-Range Precision Hand Tachometer	Centrifugal	1,000 to 6,000 rpm	Dial diameter 120mm (4.7 in.) open, easy-to-read scale
JAGABI Tachograph	Centrifugal	up to 12,000 rpm	A recording tachometer—Provides permanent chart records
DR. HORN Hand Tachometer	Centrifugal	up to 30,000 rpm	6 ranges—Simple, sturdy construction—Overspeed protection
JONES Single-Range Hand Tachometer	Centrifugal	up to 10,000 rpm	Open equi-spaced scale—with stop button
JONES Double-Range Hand Tachometer	Centrifugal	up to 5,000 rpm	Open equi-spaced scale—with stop button
JONES Triple-Range Hand Tachometer	Centrifugal	up to 50,000 rpm	Open equi-spaced scale—with stop button
JONES Stationary Tachometers	Continuous indicating fixed type	up to 10,000 rpm	3", 4" and 6" diameter dials—Uniform scale divisions—Heavy duty
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and shredders, rolling ring and special crushers for reducing chemicals, minerals, ceramics, and other materials including wood waste. Discusses construction features of the line and includes dimensions. American Pulverizer Co.

237 Spreader Stoker — Advantages and features of company's continuous ash discharge spreader stoker are detailed in 24-pp Bulletin 40. Illustrates and describes operation details, and includes diagrammatically illustrated specifications, schematic diagrams showing installations with various types of boilers, and photos of typical installations. Detroit Stoker Co.

238 Why Stainless-Clad Steel — Advantages of stainless-clad steel for coal handling equipment are detailed in this 16-pp bulletin. Photo-stories of typical applications in hoppers, chutes, bunker noses, pipes and spreaders are included. Lukens Steel Co.

239 Jet Ignition Stoker — Information regarding company's jet ignition stoker is presented in Bulletin G-85. Rapid response to load change, ignition stability, efficient combustion, and a simple hydraulic drive are features described. Jet ignition stokers adapted to boilers in specific industries are shown and a typical fuel chart with comments and ASTM rank is also included. Babcock & Wilcox Co.

FUEL BURNING EQUIPMENT

240 Steam Atomizing Oil Burners — Sixteen-pp illustrated Bulletin 21 describes steam atomizing oil burners and auxiliary equipment for use with heavy oil or tar in boilers, stills, dryers and other furnaces where steam or compressed air is available for atomizing the oil. Includes information on furnace design and construction. National Airoil Burner Co., Inc.

241 For Burning Refuse Fuel — This 8-pp bulletin describes refuse fuel burning equipment, including a pneumatic refuse fuel distributor which spreads refuse fuels such as bark, wood chips, and bagasse uniformly over the grate surface. Discusses construction features of various components. Riley Stoker Corp.

242 Oil and Gas Burners — Bulletin OB-53, 28 pp, gives principles of selection and application of oil or gas burners, or a combination of both for standard and wide capacity range operation, together with air registers and fuel oil heating and pumping sets. Conversion table shows approximate relationships between quantity of oil burned, boiler capacity and air required for combustion. The Engineer Co.

TUBING AND ACCESSORIES

243 Heat Exchanger Tubing — Cited in this 30-pp catalog are typical cases where cupro-nickel or Monel tubing installed in heat exchangers resulted in substantial savings and better efficiency through longer tube life. Describes applications of this tubing in various instances where unusual water conditions, as to pollution, excessive turbulence, temperature and the like, required such tubing. The International Nickel Co., Inc.

244 Tube Expanders — Catalog 88, 119 pp, is full of detailed information about tube expanders and associated tools used for tube rolling. Profusely illustrated, catalog provides information relative to boilers, condensers, evaporators or miscellaneous heat exchangers. Special sections

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are devoted to expanders, accessories, measuring instruments, rollers, extensions and drives. Each type of equipment is described, applications are listed, and engineering data included. Thomas C. Wilson, Inc.

245 Tube Expansion Control — Bulletin 64 describes a tube expansion control which automatically controls expansion by accurate measurement of torque. Advantages are detailed and specification data furnished. Airetool Mfg. Co.

246 Tubes and Plates — Publication B-2, 46 pp, covers the subject of tubes and plates for condensers and heat exchangers. Fields of application and particular problems encountered in each are described. Information on condenser tube alloys, plates for tube sheets and baffles, manufacturing methods, installation, operational factors affecting tube life, corrosion factors in condenser tube service is presented. The American Brass Co.

Bulletins reviewed here are offered primarily for qualified power engineers. Manufacturers may withhold literature from persons who do not state their job title and company. Some manufacturers also prefer not to send literature to those in foreign countries in which they have no sales representatives.

247 Tube Cleaners — Bulletin G-515 describes company's line of air, steam and water driven tube cleaners and accessories. Photos of the various types of cleaners are included, along with descriptive details and specification data. Elliott Co. — Roto Plant, Div., Carrier Corp.

248 Life Extension for Condenser Tubes — The 32-pp current edition of this booklet reports on research into the causes of corrosion and means of combating them, as well as the choice of condenser tube materials. Points out that Admiralty metal, long a standard for power plant condenser tubes, works satisfactorily in most installations, but other alloys may be necessary in others. Revere Copper and Brass, Inc.

WATER CONDITIONING

249 Water Treatment — Bulletin 5000, 24 pp, explains the reason for boiler water treatment and tells services offered by company in providing formulations for individual plant requirements. Covers pretreatment, internal treatment, treatment application, blow-down adjustment, test control. Dearborn Chemical Co.

250 For Boiler Protection — Scav-Ox, a 35 per cent hydrazine solution for removing dissolved oxygen from boiler feedwater, is described in this 16-pp illustrated booklet. It covers in detail the use of the solution for protecting low, medium and high pressure boilers, discussing determination of dosage, recommended methods of application, testing methods for hydrazine and properties and handling of the material. Olin Mathieson Chemical Corp.

251 Hot Process Softeners — Among information contained in 24-pp Publication 4800 is a section on conditions of water that make treatment necessary. Subjects covered in this section are reduction of silica, foaming, priming, and problems of

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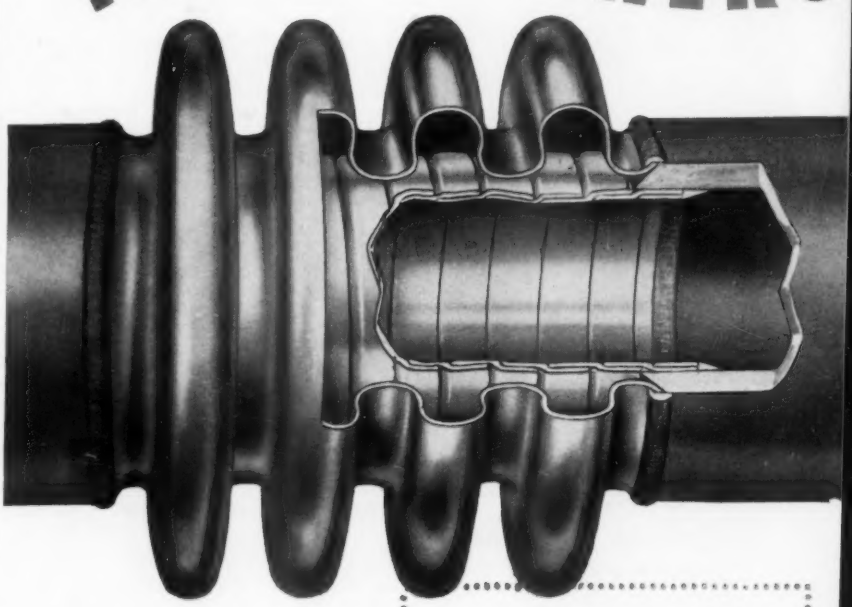

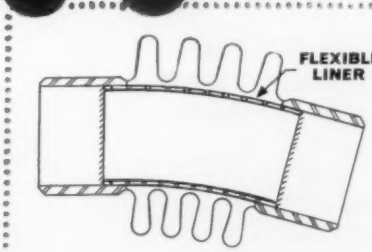

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protection against corrosion. Various types of hot process equipment are described and photos, drawings and diagrams illustrating features are included. Cochrane Corp.

252 Evaluating Steam Purity — Technical Paper 135, 88 pp, entitled "Conductivity vs Sodium by Flame Spectrophotometry. In Steam-Purity Studies," present results of laboratory and plant work to indicate that sodium is extremely valuable in evaluating steam purity. Performance curves are included in the paper. Betz Laboratories, Inc.

253 Feedwater Treatment — Process Bulletin B1, "Treatment of Boiler Feedwater by Direct, or Internal Method," discusses advantages of direct treatment, as a complete treating program or as a supplement to external systems. Explains why direct treatment is convenient, economical. National Aluminate Corp.

254 Feedwater Heaters — Open-Coil, tray-type feedwater heaters and purifiers of both deaerating and nondeaerating type are presented in 12-pp Bulletin 117-A. Construction and operational features of the heaters are explained and illustrated, and more than a dozen available models are pictured along with application suggestions. They cover capacities from 3000 to 300,000 lb per hour. Stickle Steam Specialties Co.

255 Boiler Water Treatment — Chemical reduction of oxygen in boiler feedwater with hydrazine is the subject of 10-pp Bulletin BW-7. Economy and operation, handling of the Deoxy-Sol, methods of analysis and other details are covered. A bibliography lists supplementary reading. Fairmont Chemical Co., Inc.

256 Mixed-Bed De-Ionizers — Practical equipment for mixed-bed de-ionization of flow rates of 5 gph to 5000 gpm is described in this 8-pp bulletin. Advantages of construction and design are detailed, as well as mechanical features, installation operation. Illinois Water Treatment Co.

257 Anti-Foam Agent — A cure for carryover of boiler water due to foaming is described in this illustrated brochure on Concentrol — a surface active agent of the polyalkylene glycol group. Before and after photos illustrate performance characteristics in test case. The Bird-Archer Co.

258 Preventive Treatment — Applications and advantages of Hagafilm — a film-type amine for controlling corrosion in steam condensate systems — are illustrated and described in this informative bulletin. Includes reports of typical users as well as data on testing of condensate. Hagan Chemicals & Controls, Inc.

259 pH and Chlorine Control — The 13th (1957) edition of company's handbook, "Modern pH and Chlorine Control," 100-pp, incorporating theory and practice of colorimetric analysis, serves as a reference for quantitative determination of pH, chlorine, phosphate, nitrate, sulfate, hardness and other tests. Slide comparators and complete test kits are illustrated. In addition to standard pH determinations, methods are outlined for quantitative analyses of phosphate, calcium magnesium, silica nitrate hardness. Available to qualified power engineers, please state your job title. W. A. Taylor Co.

260 Demineralization Data — Bulletin WC-111A, 32 pp, is company's revised booklet on demineralization (ion exchange). In addition to basic sections on

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application of demineralizers, principles of operation and chemistry of ion exchange resins, this bulletin includes detailed information and charts on design and materials of construction. Includes comparison charts on multi-bed, mixed-bed and scavenger or polishing demineralizers. Detailed layouts of each type of system are provided. Graver Water Conditioning Co.

FANS, VENTILATING

262 Air Engineering — Bulletin E-57 is a 24-pp air engineering data file covering engineering and test facilities for propeller fans, specifications, construction, maintenance, and installation. Tables for estimating air-handling requirements, entrance and elbow losses are provided. Aerovent Fan Co., Inc.

263 Ventilation Units — Bulletin FM-315, 25 pp, describes basic construction of company's package propeller fans for commercial and industrial applications. Illustrated case histories of typical installations are included, as well as performance data. Buffalo Forge Co.

INSTRUMENTS, CONTROLS

264 Meters and Controls — Over 100 measuring, transmitting, receiving, recording and indicating instruments and control components, including those introduced within the last year, are described in the 8-pp 1957 edition of company's Bulletin G15-1. Applications, ranges, and detailed literature references are given for each product. Bailey Meter Co.

265 Steam Calorimeter — This bulletin discusses an improved U-path calorimeter combining a throttling, separating and re-evaporating calorimeter in a single chamber. Explains construction and operation of unit. Ellison Draft Gage Co., Inc

266 For Feedwater Analysis — Bulletin 148BP contains a technical discussion of manufacturer's analyzers for determination of dissolved oxygen and hydrogen in feedwater. Discusses both O and H units as to function, ranges, accuracy. Cambridge Instrument Co., Inc.

267 Easy Reading Gage — An all-hydrostatic remote reading gage for boiler water and other liquid levels is described in Catalog 500, Section CO. Pictures improved visibility, other advantages offered by this gage, and explains operation. The Reliance Gauge Column Co.

268 Bi-Color Gage — Bulletin 1174 describes advantages of company's multi-port bi-color gage made for medium and high pressure ranges. A cutaway view illustrating component features is included, as well as drawings and photos showing installation methods. Diamond Power Specialty Corp.

269 Temperature Regulators — Ten-page Bulletin 620-2 describes features and advantages of company's line of temperature regulators consisting of a thermostat with capillary tubing and a valve. Includes information on typical applications, as well as dimensional data, diagrams, discharge pressure curves, and a valve selection chart. Sarco Co., Inc.

270 Ideas on Push-Pull Controls — Included in this "Idea File" are answers to a power engineer's questions on the use of push-pull controls. A general information booklet discusses remote control applications, explains construction and oper-

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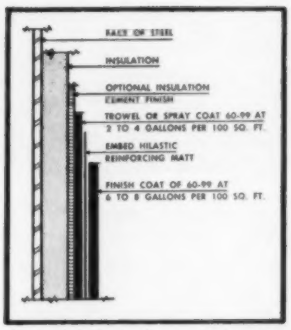
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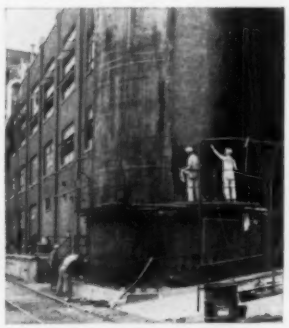

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ation of company's Tru-Lay controls. Separate bulletins are devoted to standard assemblies, bracket-type head controls, micro controls and hand-operated controls. Automotive and Aircraft Div., American Chain & Cable Co., Inc.

271 Temperature Regulators — Six-pp Bulletin 1012 describes company's line of steam regulating valves with pilots for both fast and slow heating exchangers. Selection tables and line drawings of typical applications are also included. Spence Engineering Co., Inc.

272 Instruments and Controls — Catalog 57-6 describes instruments and controls, including flow meters, liquid level or pressure gage, CO_2 meters, boiler meters, pneumatic transmitters, strip chart recorder, pressure, vacuum and differential recorders, temperature recorder, multipoint gages and others. Includes descriptive data. Republic Flow Meters Co.

MECHANICAL POWER TRANSMISSION

273 Controlled Speed Systems — Eight-pp Booklet F-1952 describes typical installations for controlled automatic variable speed systems, including control of liquid level, pressure, rewind tension, speed sensitivity, load, position or link synchronization, temperature, multiple drive conveyors, wide range speed, others. Provides information on determining preliminary planning and obtaining maximum operating efficiency. U. S. Electrical Motors Inc.

274 V-Belt Drives — Bulletin A-661, 110-pp, includes valuable engineering information, selection tables, drawings, photographs and prices for Taper-Lock Sheaves, Sealed-Life V-Belts, Flexlink Belt and variable speed drives. Tables provided to facilitate selection of pre-engineered drives. Dodge Mfg. Corp.

275 Power Transmission Equipment — Bulletin 7900-BIP, 12 pp, is designed as a general catalog on mechanical power transmission equipment. Contains selection charts for heavy duty QD sheaves, light weight and QD Junior sheaves, V-belts, and variable speed drives, including all-speed drives, motor drives, and pulleys. Worthington Corp.

PACKINGS, SEALS

276 Mechanical Packings — Featured in 24-pp Catalog 56 are several recent packing developments including the multi-purpose Bel-Vee V-Ring packings, the long wearing criss-cross braid packing series, twisted foil packings for oil and distillate temperatures to 1000 F, and an Inconel-wire reinforced plastic packing for valves handling superheated steam at temperatures up to 800 C. Packings for every industrial application are covered. The Belmont Packing & Rubber Co.

277 Packing Catalog — Catalog 54 contains literature on company's line of packings and gaskets to serve a variety of industrial needs. Among the items featured are metallic packings, fibrous packings, plastic packings, gaskets and sheet packing, as well as high-temperature anti-seize compounds. Felt Products Mfg. Co.

278 Mechanical Seals — Sealing systems for boiler feed pumps and other hot water services are described in Form S-230. Schematic boiler feed pump sealing arrangement is included, as well as other illustrative material. Crane Packing Co.

279 Mechanical Packings — Catalog P-210C contains 40 pp of detailed information on company's line of mechanical packings and gasket materials. It contains illustrations, descriptions, complete service recommendations and specification charts. Raybestos-Manhattan, Inc.

Postage-free cards for ordering catalogs are on page 122. You may also use the cards to order literature mentioned in the ads.

REFRACTORIES, INSULATIONS

280 Refractory Castable — Bulletin R-40 describes the use of Kaocrete, company's refractory castable, in boiler ashpits. A discussion of the various methods of ash removal, along with the maintenance problems peculiar to each, is presented. Four installations detailed. Refractories Div., The Babcock & Wilcox Co.

281 Refractory Mortar — This is a 24-pp manual covering the use of Lumnite calcium-aluminate cement as a mortar mix for gun-applied linings in power plant, refinery and metalworking equipment. Includes data on mortar preparation, placing procedures, curing; also general instructions, and information on use of Lumnite cement as a masonry mortar for laying brick. Universal Atlas Cement Co.

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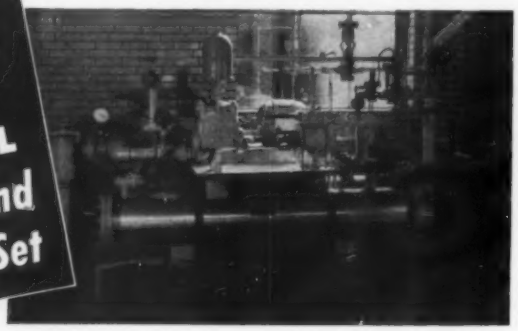

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282 **Pipe Insulation** — This 40-pp catalog was designed as a reference guide to company's pipe insulation, presenting a new way to specify proper thickness for pipe insulation, based in the "J" factor. This special index eliminates complicated computation formerly required to determine economical thicknesses. The book also features detailed drawings that show how single-layer insulation is applied to various vertical and horizontal expansion joints as well as to pipe bends, flanges, fittings. Union Asbestos & Rubber Co.

283 **Insulating Block** — An insulation block fabricated from high temperature resisting minerals and effective up to 1700 F is described in this 8-pp bulletin J-518. Provides thermal conductivity graph, size data. Baldwin-Hill Co.

ENGINES

284 **Gas Turbine Engines** — Features of company's 500-hp gas turbine engines are outlined in this 24-pp illustrated brochure. Advantages as a prime mover for mechanical drive, generator drive, air compression and other applications are detailed. Schematics and performance curves are included. Solar Aircraft Co.

285 **Steam Engines** — Bulletin 308, 8 pp, describes features and advantages of company's line of vertical type steam engines. Sectional drawings and engineering data table are included, as well as descriptions of construction details. Troy Engine & Machine Co.

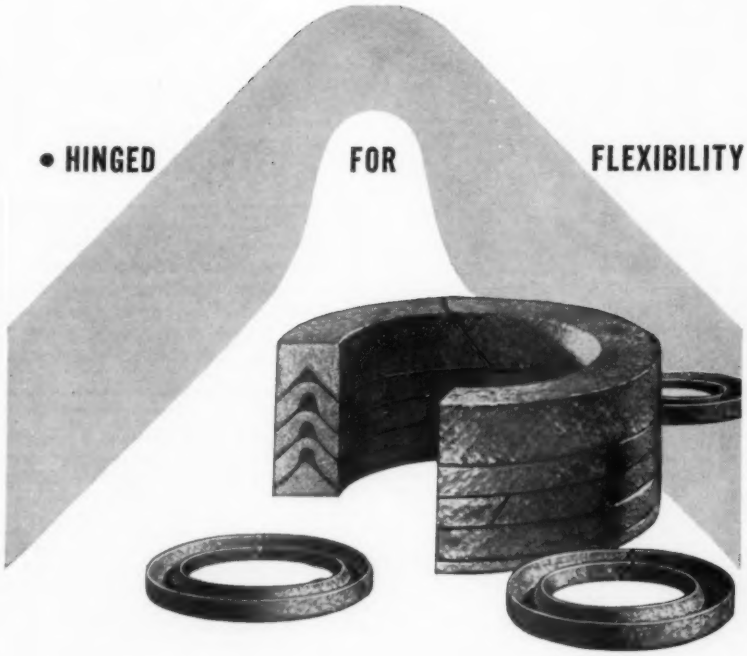
OTHER EQUIPMENT

286 **Centrifugal Dust Collector** — Twelve-pp Bulletin 100 introduces the Cyclo-trell multiple tube dust collector which operates on centrifugal collection principles and incorporates new features to boost collection efficiency and gas handling capacity. An illustrated explanation of operation and construction of this collector is accompanied by collection efficiency and capacity nomographs. Research-Cottrell, Inc.

287 **Preheating Combustion Air** — This well-illustrated 36-pp booklet explains fuel savings and increased performance made possible by using waste heat in flue gases to preheat incoming combustion air. Also covers increased boiler output, ability to use lower grade fuels, other advantages afforded. Booklet contrasts regenerative with recuperative preheaters; explains operating principle and structural details of the Ljungstrom air preheater. Applications for other than power boilers are also covered. Air Preheater Corp.

288 **Steam Turbines** — The advantages of company's solid wheel turbines, axial flow turbines, single stage and multistage, are outlined in illustrated Bulletin S-140. Describes various models in their line and includes application photos. The Terry Steam Turbine Co.

289 **Precipitation Products** — Twelve-pp Bulletin G406 contains helpful information on company's various precipitation products, including electrical precipitators, multiclone mechanical dust collectors, combination multiclone-precipitator units, Dualaire filter-type dust collectors and Holo-Flite processors. Also illustrates a number of typical installations. Western Precipitation Corp.



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290 Refrigeration Condensers — Engineering data on a complete range of sizes and types of refrigeration condensers are featured in 38-pp Bulletin RC-2. Ratings in tons refrigeration are tabulated for large and small ammonia condensers, vertical ammonia condensers, ammonia condenser-towers, freon condensers and freon condenser-towers. Selection data, dimensions, dimensional diagrams and tables of pipe sizes given. Henry Vogt Machine Co.

291 Product Guide — This illustrated 8-pp bulletin contains descriptive information on company's industrial products division and the products it manufactures, including power plant equipment, bridges, pressure vessels, process industry equipment and a wide variety of specialized products. Describes manufacturing facilities and includes production photos of manufacturing processes. Industrial Products Div., Maryland Shipbuilding & Drydock Co.

292 Sheet and Plate Fabrication — Illustrated in 40-pp Bulletin F-3 are products of this manufacturer, and equipment used to produce special sheet steel and alloy parts. Shows control panels, switch gear housings, cubicles and other electrical enclosures, boiler air ducts, smoke breechings, tanks. The Kirk & Blum Mfg. Co.

293 Steel Plate Construction — Pictured and described in this 20-pp bulletin are some of the steps in the fabrication of steel plate into boiler breechings, casings, duct work, stacks and special shapes, from initial design stage to final erection at plant site. The bulletin is generously illustrated with photos of typical plants utilizing these fabrications. They cover a wide range of industries, including paper, petroleum, steel, as well as utilities. Connery Construction Co.

294 Insulated Stack — This illustrated folder on company's pre-cast insulated stack contains complete product information, including advantages and description, specifications, suggested installation methods. Van-Packer Corp.

When ordering catalogs, allow time for us to relay your requests to the manufacturers—and for them to mail out copies. Remember, manufacturers are often swamped with catalog requests.

295 Controlled Volume Pumps — Bulletin 953, 24 pp, describes and illustrates use of controlled volume pumps in industrial water treating systems. Construction and operation features are described, capacity-pressure ranges and speed and stroke length adjustments are charted. Typical chemical feed and water testing systems are presented through text and diagrams; and an analysis of boiler water treating systems, cooling water treating problems. Milton Roy Co.

296 For Insulation Protection — Provided in this comprehensive loose-leaf manual is technical information covering practically every requirement for insulation protection. An aid to proper adaptation and application mastics, flashing compounds, adhesives and surface coatings, this book presents information classified as to industry usage, as power, process, cold storage etc. Material is also classified into product categories. Publication includes general and product data for each category. Book is available to qualified power engineers. Please state your job title when requesting copy. Benjamin Foster Co.

297 Equipment Selector Charts — Bulletin CE-50, 20 pp, contains selector charts on corrosion-resistant equipment for process industries. Tables cover general considerations in selection of material, physical properties, corrosion resistance, techniques and skill in manufacture of equipment. Describes rubber and plastic pipe, tubing and fittings; valves; pumps; lined tanks. American Hard Rubber Co.

298 Corrosion, Abrasion Control — Modern practices and products for the positive protection of metal equipment from the effects of corrosion and abrasion are described in this 16-pp bulletin. Covers factory and field application of rubber or synthetic linings to metal parts or products, and maintenance coatings available. Goodall Rubber Co.

299 Belt Conveyor Equipment — Catalog 60-B, 150 pp, features specialized data regarding application of belt conveyors for handling of materials, along with a listing of belt conveyor equipment. Included are charts and tables to assist in the selection of proper conveyor units and equipment for any specific service and location requirements. This catalog is profusely illustrated with photos, drawings and diagrams. Webster Mfg., Inc.

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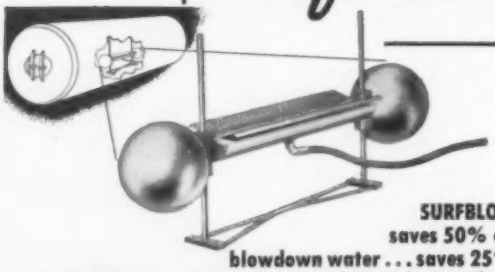

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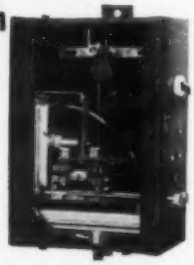

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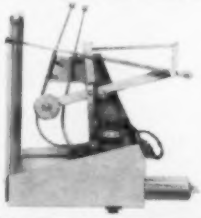

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HELPFUL BULLETINS

continued from page 32

NUCLEAR POWER APPLICATION

171 Tubing for Atomic Power — Six-pp Data Memorandum 20 on tubing for atomic power describes two major classes of applications for small-diameter tubing — fuel elements and heat exchangers. Secondary uses include reactor structural parts, coolant handling lines, piping systems, storage facilities, auxiliary processing components and general instrumentation. Typical end uses for tubing are listed as specifically as their classified nature will permit. Superior Tube Co.

172 Manual Remote Controls — Use of manual remote controls for valves is covered in considerable detail in Bulletin 589. Advantages and uses of flexible shaft and standard rigid reach rod controls for remote control of valves are detailed, applications illustrated. Stow Mfg. Co.

173 Ion Chambers — Bulletin GEA-6631 describes ion chambers highly resistant to shock and vibration which operate successfully to 300 C — for nuclear reactors. Includes technical data, specifications, on neutron-sensitive and gamma-sensitive chambers, and counters. General Electric Co.

174 Nuclear Reactor Valves — This illustrated brochure contains information on solenoid valves supplied for primary and secondary systems in pressurized water reactors. Specification and application data. Automatic Switch Co.

175 Control Rod Drives — This 12-pp brochure features the reactor control-rod drive mechanism designed and built by the company for nuclear power reactors. Presents in question-and-answer form details of design, application and operating experience of mechanisms used to control rate of heat generation in a nuclear reactor and includes installation photos and a large foldout cutaway with major parts labelled. Alco Products, Inc.

176 Nuclear Safety Aids — A variety of nuclear safety equipment and accessories is described in 8-pp Bulletin N35. Among items featured are shielded isotope storage containers, lead shields, lead glass and steel bricks, timers, remote handling tongs and pipetters, carts, calibrated absorbers, planchets, planchet cabinets, warning signs, decontaminating solution. Nucleonic Corp. of America.

177 Radioactivity Monitor — A multi-purpose radioactivity monitor which provides continuous visual and audible indications of radioactivity level for warning against hazards and for measurements in industrial, clinical, educational and research applications is described in Bulletin N-30. Specifications are included. Nucleonic Corp. of America.

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New, unused Cooper-Bessemer type JS-6-D 6 cyl. 13" x 16" Diesel. Normally rated 705 HP @ 514 RPM. Current model. Will sacrifice. Contact J. E. Smart, Bucyrus-Erie Company, South Milwaukee, Wisconsin. Phone SO 2-0900.

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3	So You're Going To Overhaul Your Turbine Generator—48-page reprint of series of articles on details of U. S. Steel Co. 25,000-kw turbine overhaul.	1.00
4	Industrial Ventilation—8-page manual presents new, thought-provoking ideas on industrial ventilation. Such points as measuring and controlling radiant heat and how to find the comfort range are discussed.	0.25
5	Effective Start-Up Engineer Smooths Out Preliminary Power Plant Operation—16-page reprint covers effective scheduling of start-up, checking of condensate, boiler feed and circulating water systems and steam lines before start-up, and running in of auxiliaries. By J. H. Hunnicutt	1.00
6	Fluid Power Maintenance—48-page reprint of series of 12 articles on hydraulic and pneumatic industrial applications.	1.00
7	Your New Industrial Power Plant—How To Get It Into Operation—24-page reprint of series of articles by Paul N. Garay from 1957 issues on building your new plant right, how to set up operating records and train operators, tools and stores, procedure in getting ready to operate.	1.00
8	Industrial Maintenance—36-page reprint of 11 articles appearing in past issues of Plant Engineering.	1.00
9	What It Costs to Modernize Small Industrial Power Plants—24-page reprint of series of articles by H. D. Fisher from 1957 issues, giving six case studies of plants from 25,000 to 50,000 lb. of steam per hour capacity.	1.00
10	Cherry Hill—16-page reprint of article describing what construction preplanning is necessary. Article discusses use of consultants, methods of bidding, basic concepts, selling the project to management, details of project and cost-saving ideas.	0.50
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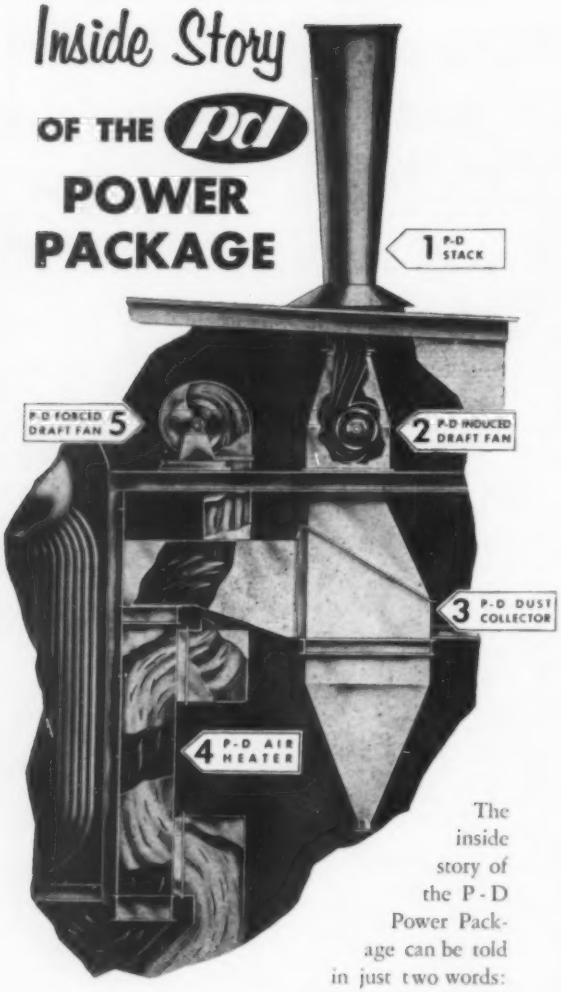

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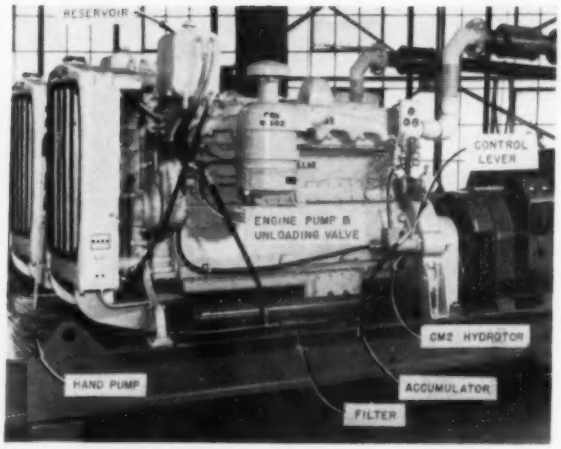

Fig. 1. Typical installation of hydraulic starter, on twin diesel-generator-drive units. Component parts are indicated

Hydraulic Starters Gain Momentum

AMERICAN BOSCH ARMA Corp has purchased Hydramotive Inc, which has developed a hydraulic starter for all types of diesel and gasoline engines.

Hydraulic starters such as this Hydrotor have several advantages over conventional diesel starting systems. Winter starts are easier and surer, a feature which solves a tough operating problem for engine operators in northern sections of the United States.

In hazardous locations such as refineries, oil tankers, magazines, and power boats, use of this device reduces the danger of explosion or fire to a minimum during starts. There are no electrical switches or motors or batteries, hence no danger from arcing between contact points or from battery fumes. Maintenance costs are sharply reduced as expensive replacement of batteries and wiring is eliminated with the system.

Hydrotor system is composed of three main units, the hydraulic starter which incorporates a positive displacement hydraulic motor for rotation, a hydraulic pressure accumulator for storing up sufficient pressure for several starts, and a hydraulic pump either hand-operated or engine-driven.

Choice of a hand or engine-driven pump depends on the needs of the engine operator. For example, operators of diesel power plants might prefer hand pumps since their equipment is started only once during long operating periods. On the other hand, coal-handling-equipment operators may choose an engine-driven pump, as their equipment may be started many times during the year.

Simplicity of the system, it is claimed, insures dependable operation with minimum maintenance.

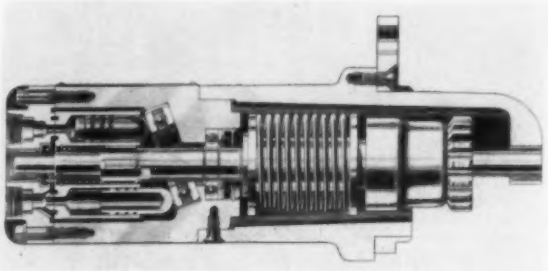

Fig. 2. Positive-displacement hydraulic motor. Pressure on movable plungers forces them against tilted ball bearing, causing unit enclosing plungers to rotate, turning starter

Watch the Air Supply for that Gas Turbine Compressor!

One per cent reduction in compressor efficiency will reduce net turbine output and efficiency as much as two per cent

SINCE the installation of the first commercial land gas turbine in 1949, American manufacturers have sold over 250 gas turbines for commercial service. These machines have ranged in size from 1200 kw to 21,800 kw (standard rating at 80 F-1000 ft altitude).

Speaking on Equipment for Stationary Gas Turbine,* D. L. E. Jacobs and I. H. Landes discussed the problem of getting the air into the compressor. Air requirements range from 349,000 lb per hr (approximately 82,000 scfm) for a 5300-kw unit to 1,370,000 lb per hr (approximately 322,000 scfm) for a 21,800-kw unit. Air should be ducted in from the outdoors.

Air entering the compressor must be clean to avoid erosion or deposition, either of which will reduce compressor efficiency, and increase maintenance. Since a reduction of one per cent in compressor efficiency will reduce net turbine output and efficiency by approximately two per cent, it is important that compressor efficiency be maintained at a high level. Most of the gas turbines installed in this country to date have been equipped with inlet-air filters.

Thus compressor-inlet air should be drawn from the outdoors through a filter and ductwork to the inlet hood of the unit. It would be tempting to save money on ductwork and perhaps on the filter by operating with very high air velocities, taking a pressure drop of 10 to 15 in. of water between the atmosphere and the inlet hood. However, filters should be selected and ducts designed with a full understanding of the effect of pressure drop.

Inlet pressure drop has the effect of causing lower output and efficiency by reducing the air flow through the machine and reducing the pressure ratio across the turbine. In the first case, inlet pressure drop reduces the density of the air entering the compressor. This reduction in density decreases the mass flow of air since at a given speed the compressor operates with essentially a constant-volume flow. The second condition occurs because the compressor operates at almost constant pressure ratio. With inlet pressure reduced, the compressor-discharge pressure also drops. The decreased pressure ratio now available to the turbine thus results in reduced turbine output.

In many cases, the capacity lost due to pressure drop must be replaced either by additional installed capacity or purchased power.

In discharging hot gas from turbine to atmosphere, pressure drop is again of importance, though the effect is not so great as on the inlet side.

Inlet Filtering

The two basic types of filters that have been applied in gas-turbine installations are: viscous type — filtration through viscous-coated filter panels; dry type — filtration through glass fiber pads.

The viscous-type air filter can be automatic, self-cleaning filter that is cleaned and recharged by passing it through an oil reservoir. Maintenance is limited to the removal of sludge from the cleaning tank and replacement of oil in the reservoir. For the range of gas turbines now available, 5300 to 27,500 kw, a stock of 20 to 60 gal of oil a year should be sufficient to replace oil taken off with the sludge.

The automatic dry-type filter is a long glass-fiber blanket rolled on a spool. During operation the filter is fed from the supply spool to a discard spool after having accumulated dirt load. The rate at which the timing device drives the blanket requires a replacement of the filter roll about every four months with normal dirt loading and atmospheric conditions.

*ASME Paper No. 57—A-142

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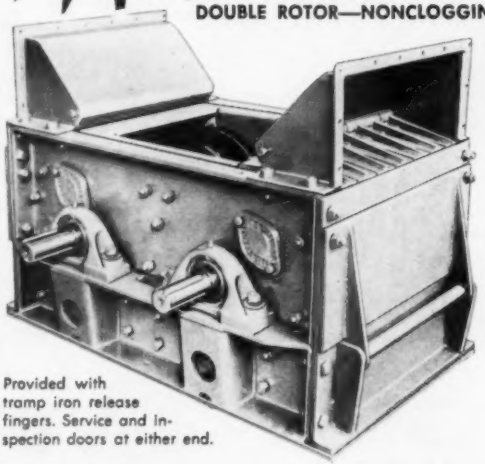

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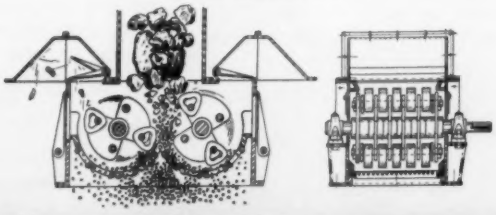

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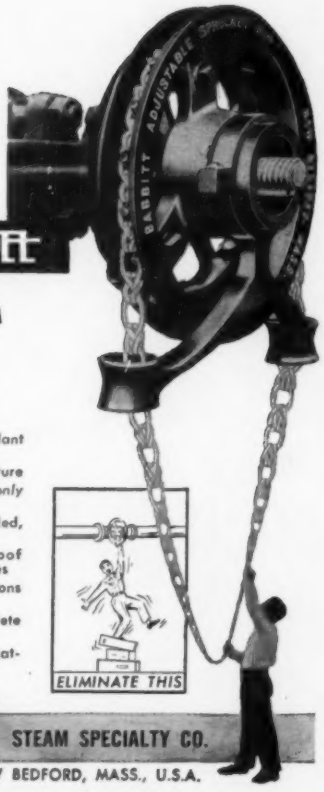

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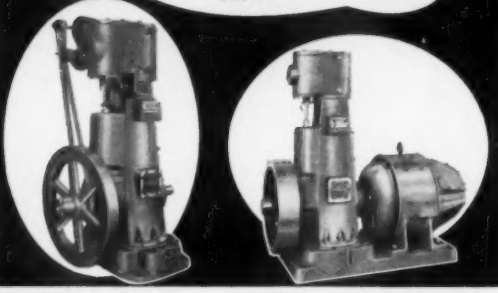

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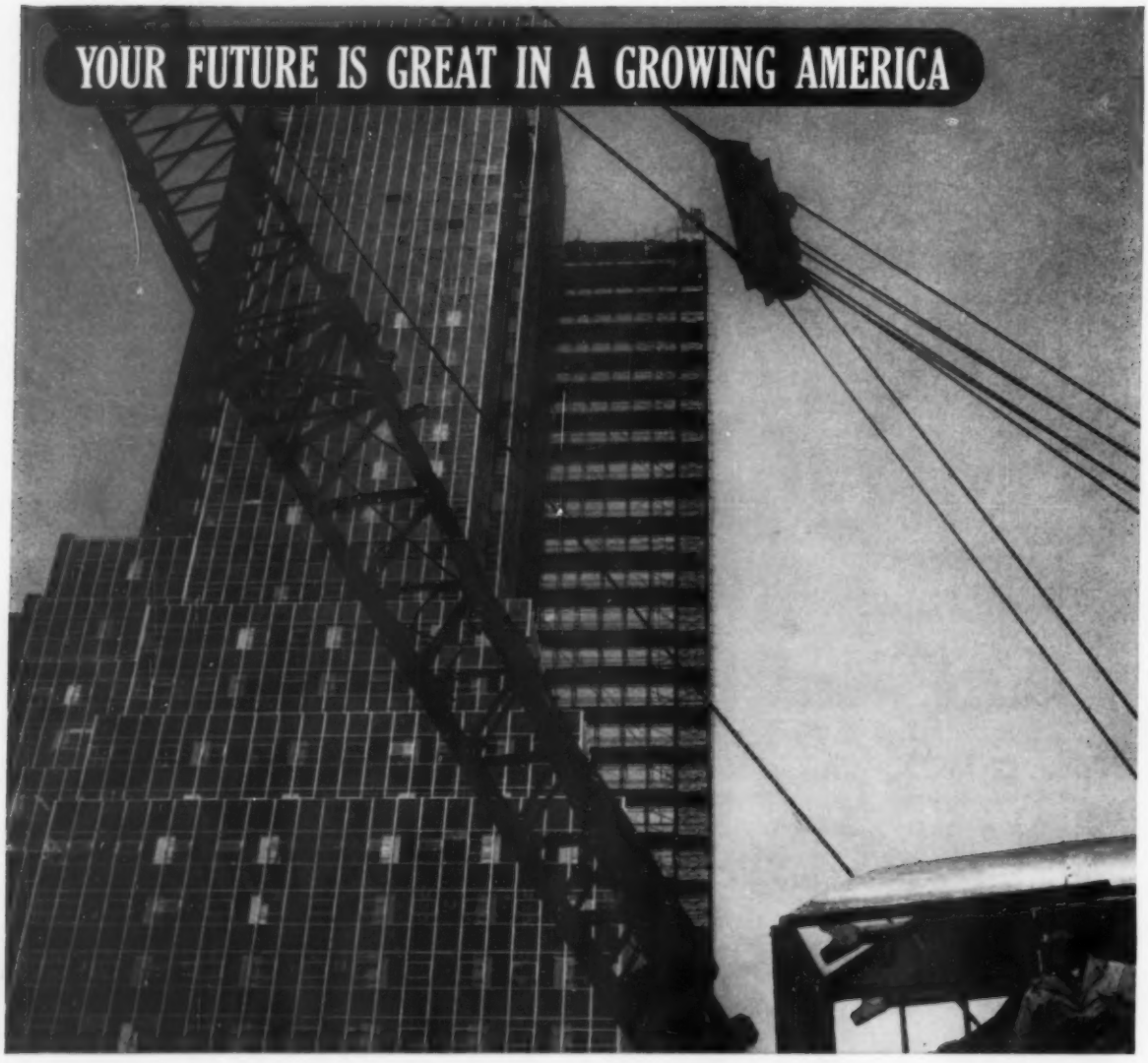

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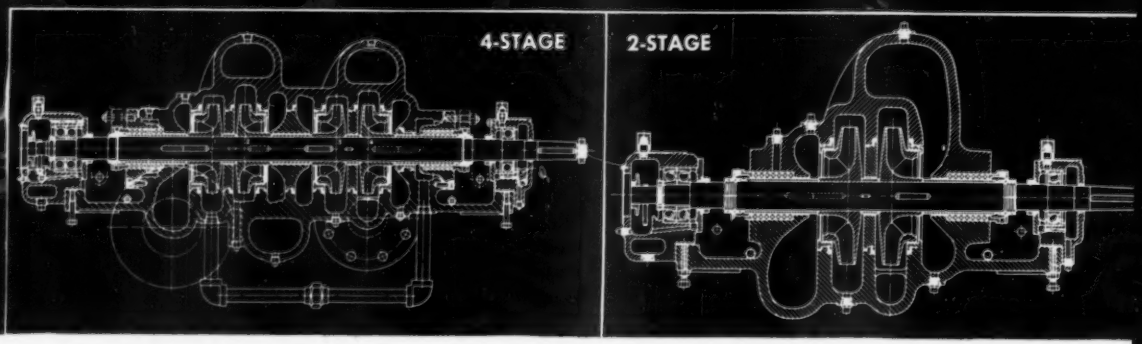

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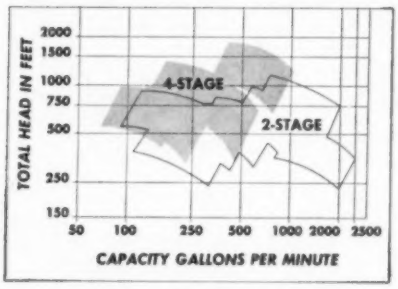

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